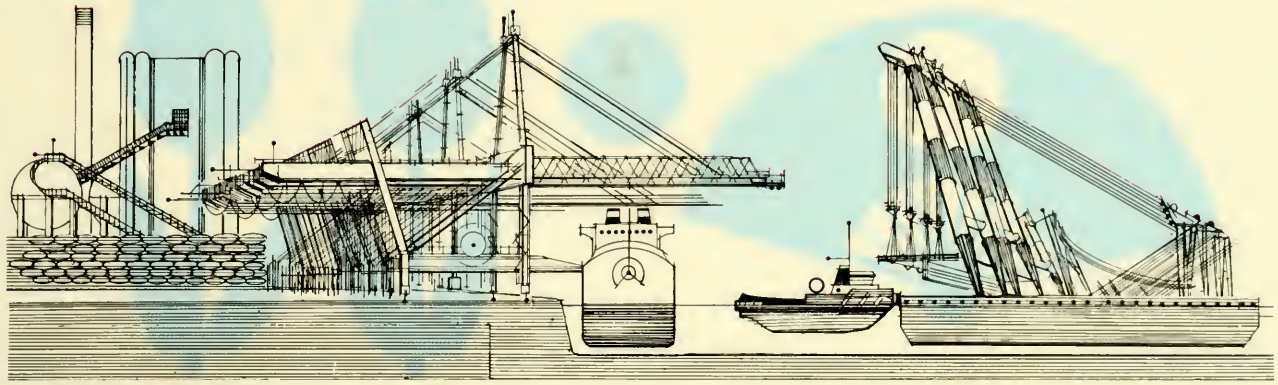

Oceanus®

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The Bismarck Saga

1941-1989

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Modernized

Gentrified

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Introduction

Sending "Sink the *Bismarck*!" to the Bottom

As astute readers will have noted from the cover, this issue of *Oceanus* has two themes – the exciting discovery by a Woods Hole explorer of the World War II German battleship *Bismarck*, sunk by the British in 1941 in one of the greatest naval engagements in history; and the mounting pressures on ports and harbors, particularly in the United States, to turn more waterfront space into various forms of economic tattoo parlors.

The nine-day pursuit and sinking of the *Bismarck* is one of the greatest sea stories of all time, ranking with Salamis, Lepanto, the Spanish Armada, Trafalgar, Tsushima, Jutland, Midway, and the Coral Sea. The saga, with fortunes veering from one side to the other, embraces many of the elements of ancient mythology – pursuit, discovery, escape, fear, courage, victory, defeat, and death. We hope you enjoy the *Oceanus* version of this classic confrontation, which comes on the 50th anniversary of the start of World War II.

But before you begin, let us torpedo one myth that may prove as difficult to sink as the *Bismarck*. Everyone remembers the great Churchillian edict to "Sink the *Bismarck*!" After all, it appeared in the book and movie by the same name. In those accounts, the Flag Officer on duty in the Admiralty was summoned to the intercom shortly after the sinking of the *Hood*:

> *From out of the box came the unmistakable tones of the Prime Minister's voice.*
>
> *"Your job is to sink the* Bismarck*," said the box. "That is your overridding duty. No other considerations are to have any weight whatever."*
>
> *"Yes, Prime Minister."*
>
> *"What about* Ramillies*? What about* Rodney*?"*
>
> *"Orders are being issued at this moment, Prime Minister."*
>
> *"*Revenge*? Force H?"*
>
> *"They have their orders."*
>
> *"You're taking every possible step to see that* Bismarck *is going to be sunk?"*
>
> *"Yes, Prime Minister."*
>
> *"Not only the possible steps, not only the easy steps and the obvious steps, but the difficult steps and the almost impossible steps, and all the quite impossible steps you can manage as well. The eyes of the whole world are upon us."*

Sounds Churchillian to me, but perhaps you missed the small print at the beginning of C.S. Forester's "true story of Hitler's mightiest battleship."

This is as it may have happened. The speeches are composed by the writer, who has no knowledge that those words were used...

Alas, our research indicates that Churchill never uttered the famous cry attributed to him. In *The Second World War*, Volume 3, *The Grand Alliance* by Winston S. Churchill, we get a feeling for what really transpired:

> *I went to Chequers on Friday afternoon (May 23). Averell Harriman and Generals Ismay and Pownall were to be with me till Monday. With the Battle of Crete at its height it was likely to be an anxious week-end. I had, of course, a most complete service of secretaries in the house, and also direct telephone connections with the duty captain at the Admiralty and other key departments. The Admiralty expected the* Bismarck *and the* Prinz Eugen *to come through the Denmark Strait in the early dawn, and that the* Prince of Wales *and the* Hood*, with two or three cruisers, would bring them to battle. All our ships were moving towards the scene in accordance with the general plan. We spent an anxious evening, and did not go to bed until two or three o'clock.*
>
> *At about seven I was awakened to hear formidable news. The* Hood*, our largest and also our fastest capital ship, had blown up. Although somewhat lightly constructed, she carried eight 15-inch guns, and was one of our most cherished naval possessions. Her loss was a bitter grief, but knowing of all the ships that were converging towards the* Bismarck *I felt sure we should get her before long, unless she turned north and went home. I went straight to Harriman's room at the end of the corridor, and, according to him, said, "The* Hood *has blown up, but we have got the* Bismarck *for certain." I then returned to my room, and was so well tired out that I went to sleep again. At about half-past eight my principal private secretary, Martin, came into the room in his dressing-gown with a strained look on his ascetic, clear-cut face. "Have we got her?" I asked. "No, and the* Prince of Wales *has broken off the action." This was a sharp disappointment. Had then the* Bismarck *turned north and gone home? Here was my great fear. We now know what happened.*

Our research indicates that Churchill did send a message on the final day of the saga to the Admiralty to the effect that the *Bismarck* was

August, 1941.

to be sunk at all costs and that the *King George V* was to keep shooting even if she ran out of fuel and had to be tugged back. The message was not received until after the *Bismarck* went down.

For the most part, we have concentrated on giving you a historical view of the little-known American involvement in the *Bismarck* saga. You will find an account of the final days of the *Bismarck* by U.S. Navy Captain Joseph H. Wellings aboard the *HMS Rodney*; the crucial spotting of the *Bismarck* by an American pilot flying as an observer in a Catalina flying boat; and the mistaken, near-sinking of a U.S. Coast Guard cutter in the action. We, of course, also present our version of The Quest to Find the *Bismarck*!

* * *

As the articles in our section on Ports & Harbors point out, economic conditions are fostering fierce competition among those with waterfront development interests. This competition extends from Tokyo and Rotterdam to the more than 80 major seaports in the United States.

On one side of the waterline, ports are the captives of the demands of shipping lines, the oil and gas trade, the critical-resources traders, cruise ship lines, fishing interests, and recreational users; while on the other side, pressures come from city merchants with dreams of condominiums, hotels, restaurants, museums, aquariums, and the like, capitalizing on a romantic notion of the rough-and-tumble waterfront of a bygone era.

The fact that stevedores today can make up to $100,000 a year at their computerized cranes should be enough to prompt Hollywood to remake *On the Waterfront* with Kevin Costner in the role of a modern-day Marlon Brando. It could be an Academy Award contender.

Seriously, the ports and harbors of our nation face many critical problems, ranging from defense to dredging. We hope that our coverage, which was guided by the advice, contacts, and editing of Michael Champ of the National Science Foundation, will acquaint you with some of these issues, not the least of which is the environmental component, and how other countries are preparing for trade in the 21st century.

There is a bill before the Senate as I write this introduction that would create a National Maritime Enhancement Institute. The Institute would be charged with conducting research on methods to improve the maritime industry's performance, including assessing technological advancements and developing a management training program. The bill passed the House of Representatives. The leading contender to establish the new Institute is Louisiana State University, which, in conjunction with George Washington University, is now the home of the Ports and Waterways Institute.

* * *

My Fulbright experience in Japan and China will be related in the winter issue of *Oceanus*, which will be devoted to marine affairs in the Pacific region. The focus will be on new Soviet and Chinese initiatives in this region and how the tragic events of Tiananmen Square may affect the balance of power in the upcoming Pacific Century.

I would like to take this opportunity to thank Fred Golden, who stood in for me as Acting Editor during my nine-month leave of absence. It is no easy job to step into another's deck shoes as Fred did, but the three issues he commanded—the Update of the Oceans and Global Warming, Whither the Whales?, and the *Alvin* Anniversary Issue—speak for themselves. Fred reports that he is happily writing and free-lancing science articles from his boat in San Francisco Bay.

"Don't worry. Be happy" is his message to all of us.

—Paul R. Ryan
Editor, *Oceanus*

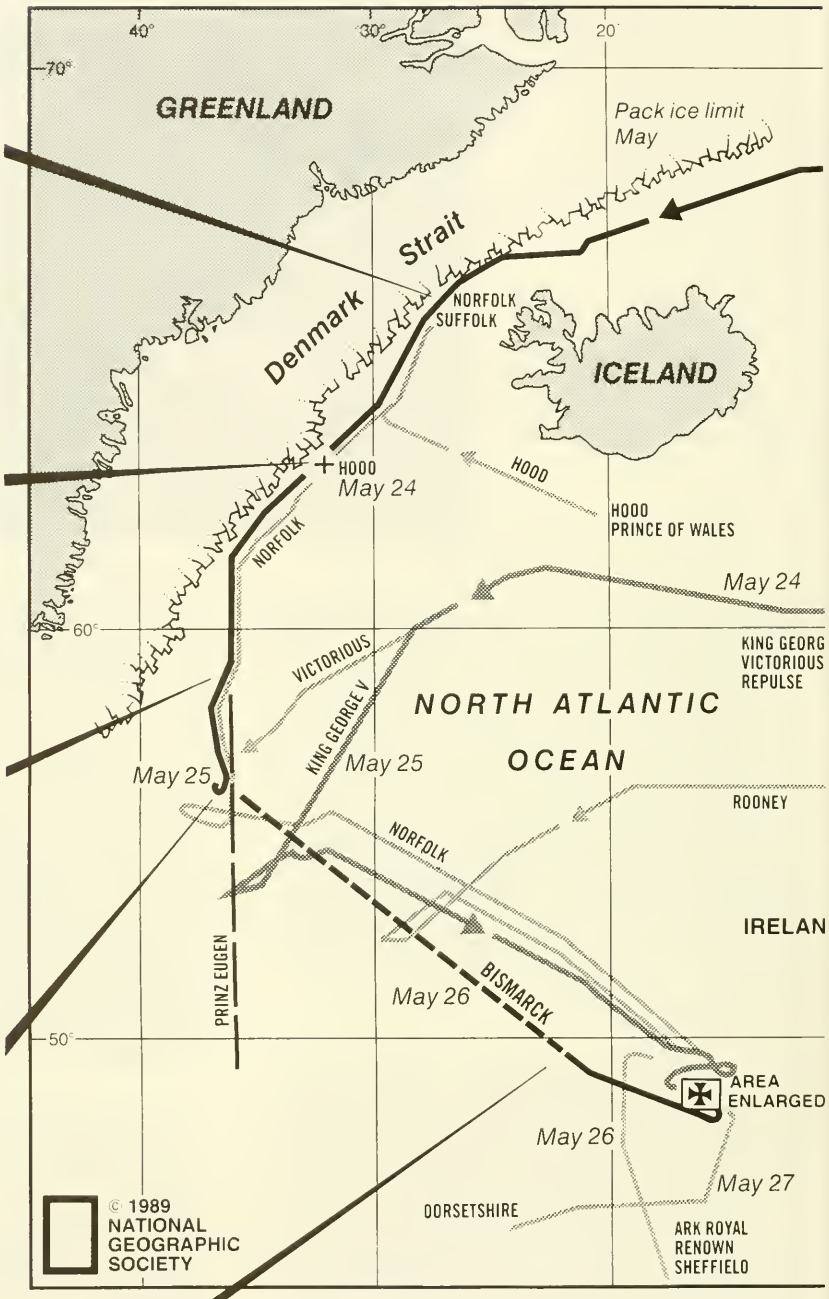
4 The cruisers *Suffolk* and *Norfolk* sight the Germans threading through a minefield May 23. The *Bismarck* opens fire on the *Norfolk* but the British retire safely. They follow the Germans despite rain and snow storms and dangerous ice floes. The *Hood* and *Prince of Wales* are about 250 miles away and closing in.

5 The *Hood* and *Prince of Wales* sight the *Bismarck* at 5:35 a.m. May 24. They open fire. The *Bismarck* and *Prinz Eugen* return fire. At 6:01 a.m. a massive explosion erupts aboard the *Hood*. It sinks rapidly, leaving only three of 1,419 crewmen alive. The *Bismarck* suffers a ruptured fuel tank.

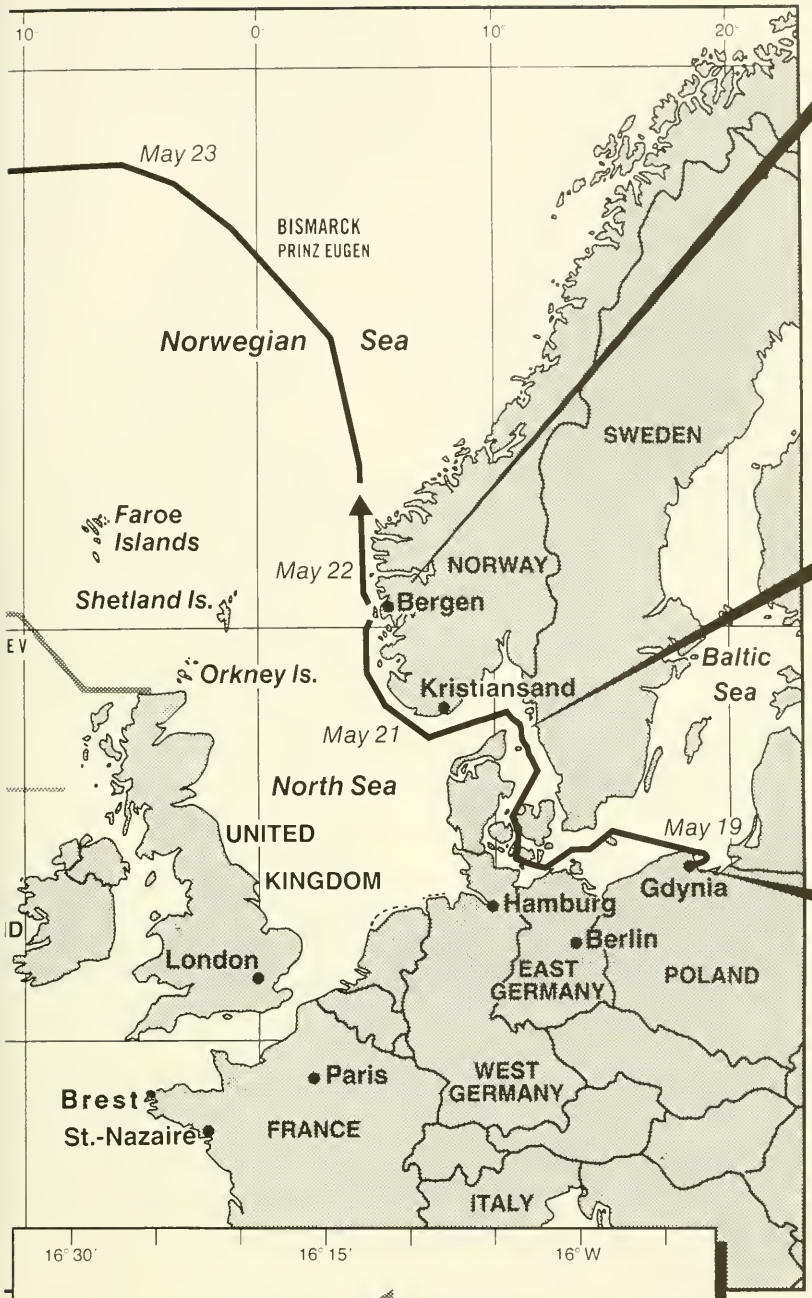
6 As the *Bismarck* engages the British again on the evening of May 24, the *Prinz Eugen* escapes to the south. The *Bismarck*'s commander has decided to make for a French port for repairs. A British force including the aircraft carrier *Ark Royal* heads to the area from Gibraltar.

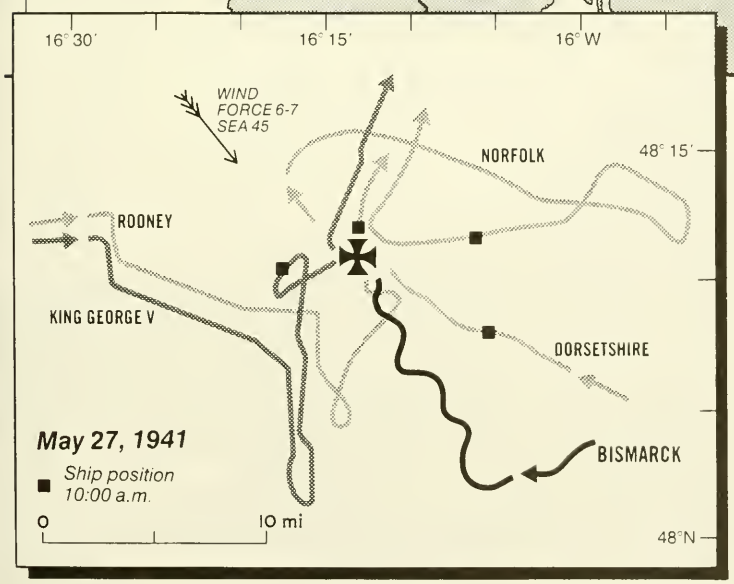
7 Around midnight May 24, amid raging seas, nine Swordfish biplanes from the carrier *Victorious* attack, causing little damage. About 3 a.m. the *Bismarck* evades its chasers and heads southeast for the safety of U-Boat patrols and Luftwaffe air cover.

8 A reconaissance plane from Ireland spots the *Bismarck* May 26. In a last-ditch effort to stop the ship before it reaches safety, Swordfish from the *Ark Royal* score two torpedo hits that wreck her steering gear and jam her rudders, effectively sealing her fate.



9 The main British force sights and opens fire on the *Bismarck* beginning at 8:47 a.m. May 27. The battleships *King George V* and *Rodney* turn south to give the north-sailing Germans broadsides. Two other vessels, the *Norfolk* and the *Dorsetshire*, join the attack. Turning north, the *King George V* and the *Rodney* quickly overtake the limping *Bismarck*. The *Rodney* zigzags in front, pouring on fire. After a few good early shots, the *Bismarck*'s fire quickly becomes erratic. By 10 a.m. the ship is a battered hulk. By 10:39 a.m. she has capsized and sunk.



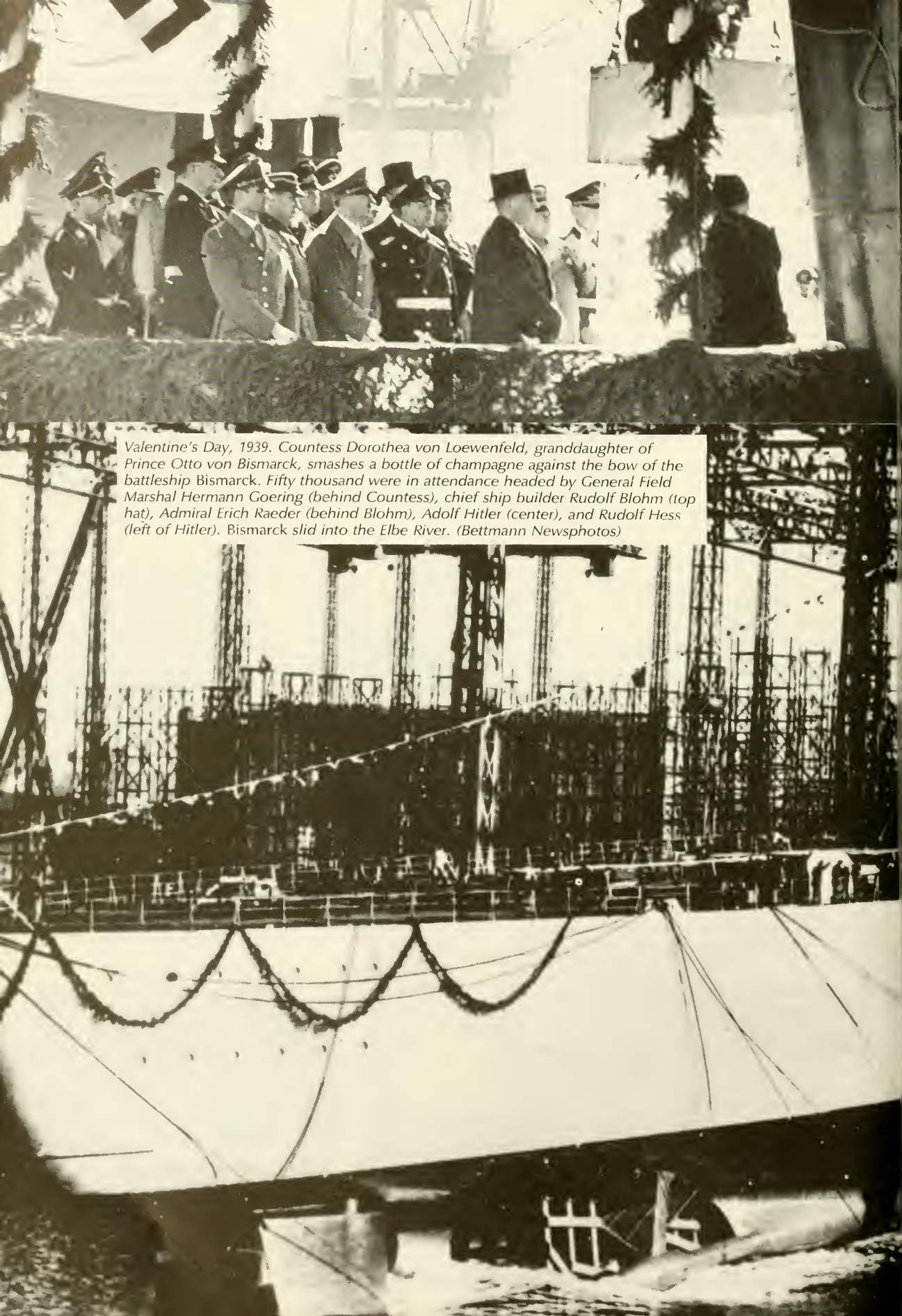


3 On May 21, Spitfires over the Bergen-Korsfjord region of Norway sight the *Bismarck* and *Prinz Eugen*. British Admiral Tovey sends the battle cruiser *Hood* to join other British ships on patrol in Denmark Strait. On May 22, a reconnaissance flight determines that the two German vessels have sailed. More British forces head for the search zone.

2 A Swedish cruiser spots the *Bismarck* and its escort, the *Prinz Eugen*, in the northern Kattegat off the coast of Sweden on May 20. A later sighting places them off the coast of Kristiansand, Norway.

1 Under construction at Hamburg since 1936, the *Bismarck* is launched on Valentine's Day, 1939, by Adolf Hitler. After more than two years in fitting and shakedown cruises, she sets sail May 19, 1941, from Gydnia, Poland, with orders to sink Allied shipping in the Atlantic.

Last days of the *Bismarck*

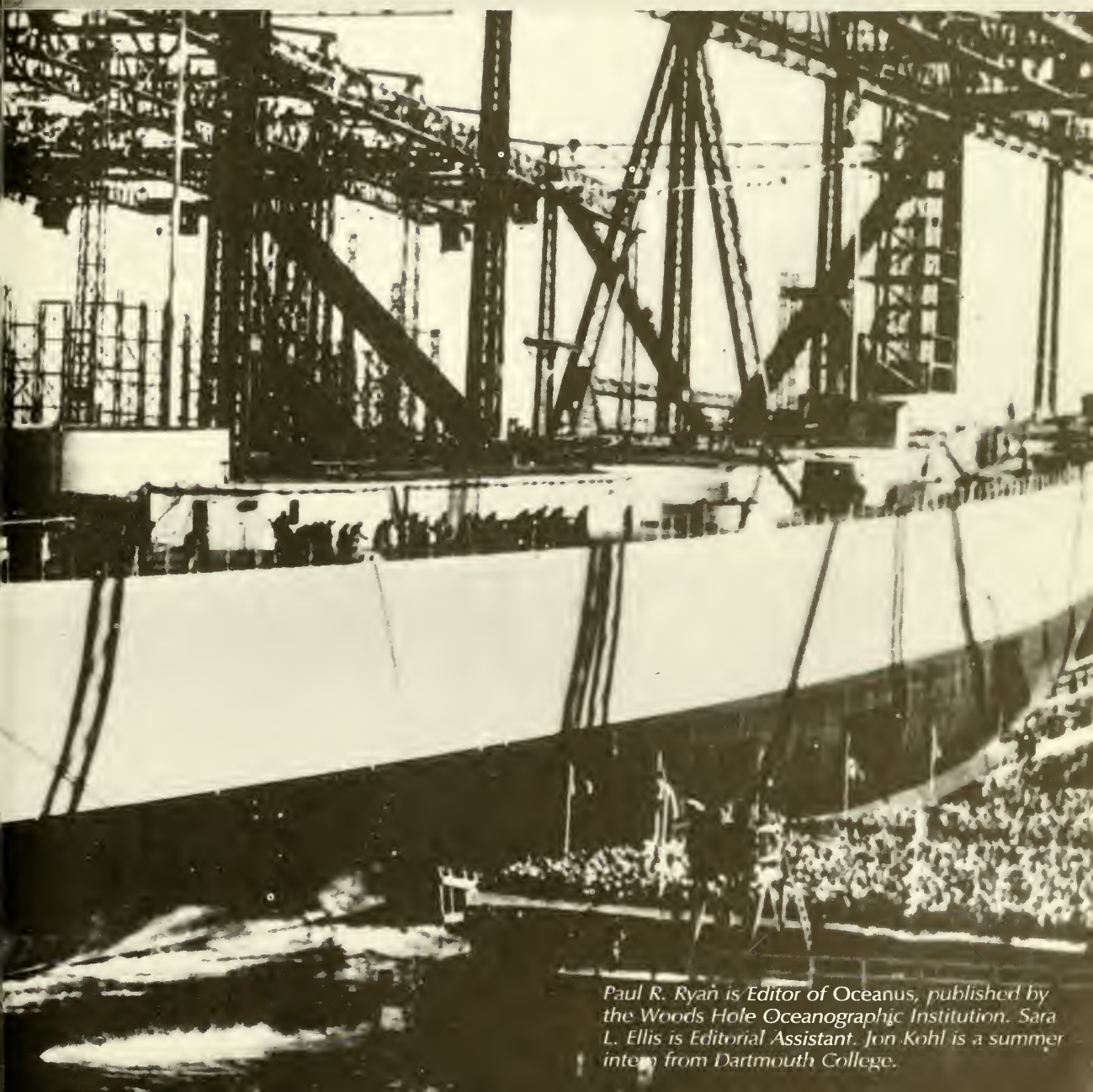


Valentine's Day, 1939. Countess Dorothea von Loewenfeld, granddaughter of Prince Otto von Bismarck, smashes a bottle of champagne against the bow of the battleship Bismarck. *Fifty thousand were in attendance headed by General Field Marshal Hermann Goering (behind Countess), chief ship builder Rudolf Blohm (top hat), Admiral Erich Raeder (behind Blohm), Adolf Hitler (center), and Rudolf Hess (left of Hitler).* Bismarck *slid into the Elbe River. (Bettmann Newsphotos)*

The Bismarck Saga

1941 – 1989

by Paul R. Ryan, Sara L. Ellis, and Jon Kohl



Paul R. Ryan is Editor of Oceanus, *published by the Woods Hole Oceanographic Institution. Sara L. Ellis is Editorial Assistant. Jon Kohl is a summer intern from Dartmouth College.*

How much would the U-boat warfare reduce our imports and shipping? Would it ever reach the point where our life would be destroyed? Here was no field for gestures or sensations; only the slow, cold drawing of lines on charts, which showed potential strangulation. Compared with this there was no value in brave armies ready to leap upon the invader, or in a good plan for desert warfare. The high and faithful spirit of the people counted for nought in this bleak domain. Either the food, supplies and arms from the New World and from the British Empire arrived across the oceans or they failed.

Winston Churchill
From **The Second World War,** *(Vol. II)*

One of the greatest air-sea searches in naval history occurred in the spring of 1941, when Britain's fortunes were at a low ebb in World War II. In the span of little more than a week, the huge German battleship *Bismarck* sank the proudest ship in the Royal Navy—the battle cruiser *Hood*—but within 72 hours she was crippled by the British Fleet Air Arm, pounded into a defenseless wreck by British warships, and scuttled by her own crew.

The British lost 1,416 men when the *Hood* went down in the first engagement of the epic saga; only three survived. More than 2,200 men went down with the *Bismarck*; 112 survivors were picked up by the British, and a German U-boat saved another three. In a bombing raid after sinking the *Bismarck*, the British also lost the destroyer *Mashona* to the German Luftwaffe with the loss of one officer and 45 men.

From March of 1940 until the encounter with the *Bismarck*, the Germans enjoyed a position of superiority on the high seas. The British were defending their important mercantile convoys with battleships. The German plan, known as the *Rheinübung,* or "Rhine exercise," was to attack the convoys with a superior force composed of the aircraft carrier *Graf Zepplin* and the pocket battleships *Scharnhorst* and *Gneisenau* in a pincer movement out of their southern base at Brest, France, combined with their new warship *Bismarck* and the heavy cruiser *Prinz Eugen*, which would reach the Atlantic shipping lanes from the north. This, the Germans felt, would give them command of the North Atlantic, cutting off Britain's lifeline.

The German plan, however, received a major setback in early April of 1941 when the *Gneisenau* was knocked out of commission during an RAF bombing mission that braved murderous antiaircraft and ship fire in an effort to disable the ships in for repairs at Brest. The RAF pilots were acting on an edict of Prime Minister Winston Churchill that "serious risks and sacrifices" had to be made to destroy the German ships.

Guy Gibson, in *Enemy Coast Ahead,* a testament to the British Bomber Command, has written: "The crews couldn't see them [the German ships]. Moreover, not only the glare of hundreds of searchlights, the many decoys, coupled with the thousands of flak shells filling the skies above the very small target area, made it virtually impossible even to hit the docks, let alone the ships. Even when our bomber formations had bombed Brest by day, the Germans would fill the whole area with thick yellow smoke, which completely hid everything from view. When I say that in order to get to the docks it was necessary to do a five-minute timed run from an island nearby, it will possibly be realized why no serious damage was done."

Flying into more than a thousand flak guns, apart from those of the ships themselves, a British bomber managed to put a torpedo into the *Gneisenau* seconds before the plane was shot down with loss of the entire crew. The *Scharnhorst,* meanwhile, needed an engine refit and would not be ready for service until June; and the *Prinz Eugen* hit a mine on 23 April, necessitating a 14-day repair.

Despite these setbacks, the German High Command decided to press forward with the *Rheinübung* and have the *Bismarck* and the *Prinz Eugen* break out into the North Atlantic. Meanwhile, the British Admiralty had intelligence reports that the *Bismarck*—the fourth ship to bear the name of the "Blood and Iron" Chancellor who ironically had seen no need for his country to possess a navy—was nearly ready for sea.

Both the *Bismarck* and the *Prinz Eugen* left the occupied Polish port of Gdynia on 19 May on the first leg of the saga. On the 20th, the British received reports via Sweden that the two warships had been spotted passing through the Kattegat, or "Great Belt," screened by 11 merchant ships. The British immediately launched an intense air search. The following day, the German ships were spotted by special RAF reconnaissance Spitfires in Grimstad Fjord, just south of Bergen, Norway, where the *Prinz*

Bismarck, *left, in Grimstad Fjord, from 25,000 feet up, 21 May 1941.*

Eugen was topping off with fuel for the breakout into the North Atlantic.

The British Home Fleet, meanwhile, was located at Scapa Flow in the Orkney Islands, and was under the command of Sir John Tovey. The fleet was composed of two battleships, the *King George V* and *Prince of Wales*; two battle cruisers, the *Hood* and the *Repulse*; and one aircraft carrier, the *Victorious*. The *Bismarck*, however, was larger than any British battleship and carried a main armament of eight 15-inch guns, a caliber one inch larger than those of the British battleships. It also was faster than any of the British battleships afloat, and had a well-trained crew. On the British side, only the *King George V*, Admiral Tovey's flagship, was regarded as a fair match for the *Bismarck*. The *Repulse* was 25 years old with fewer big guns than the *Bismarck*, and the *Hood* was more than 20 years old with thinner armor. The *Prince of Wales* and *Victorious* were new ships to the fleet and far from combat readiness.

Admiral Tovey was by no means sure at this point whether the German warships were indeed attempting a breakout into the North Atlantic to harass British shipping. They might have been acting only as a convoy escort to Norway and be planning a return to Germany, or as a cover for an attack on the Faroe Islands or Iceland. If it was a breakout attempt, there were four possible passages for the German ships to take: There was the Denmark Strait between Iceland and the east coast of Greenland—the most favored route for German breakouts in the past; there was the passage between Iceland and the Faroes; there was the strait between Faroes and the Shetlands; and there was the Fair Island Channel between the Shetlands and the Orkneys.

The cruiser *Suffolk* was already on patrol in the Denmark Strait, where the ice pack had narrowed the navigable channel to 60 miles from a range of 250. Tovey told the *Suffolk* to keep a sharp eye out at the edge of the ice pack, and also dispatched the cruiser *Norfolk* to aid in the patrol. He also sent a battle squadron to Hvalfjord in Iceland composed of the battle cruiser *Hood*, under the command of Vice Admiral L. E. Holland, and the new battleship *Prince of Wales* with Captain J. C. Leach in command of a crew that sailed so hastily from port it contained civilian shipyard workers, plus six destroyers. Tovey himself remained in the battleship *King George V* in Scapa Flow with five cruisers and five destroyers.

At this point, the weather closed in. For the next 24 hours, the British were effectively blind. In the *Bismarck*, the German Fleet Commander, Admiral Günther Lütjens, seized

Admiral Sir John Tovey

Admiral Günther Lütjens

Captain Ernst Lindemann

the opportunity. He ordered his Captain, Ernst Lindemann, to sail at once. They took a course heading for the Denmark Strait, relying on an erroneous Luftwaffe report that all the British battleships were still at Scapa Flow.

It was not until the evening of 22 May that Admiral Tovey learned from a Royal Navy reconnaissance plane, braving extremely foul weather, that *Bismarck* and *Prinz Eugen* were not in Grimstad Fjord or Bergen. Within three hours,

Admiral Tovey was at sea with the Home Fleet, heading for the southern exit of the Denmark Strait.

But the weather was still a big problem – mostly rain and heavy mists, with visibility at times closing down to 150 yards. Admiral Tovey, of course, had no way of knowing for sure that the German ships were not anchored in some small Norwegian fjord, or heading back to Germany. Most of his air patrols were grounded. Thus, Admiral Tovey was forced to rely on the vigilance of his widely scattered cruiser force.

On the evening of 23 May, the *Suffolk* was patrolling the open waters up to the edge of the Greenland ice pack, while the *Norfolk* was patrolling in the heavy mists which extended to the shores of Iceland. The *Suffolk* was outfitted with the latest radar, unbeknownst to the Germans who had launched the *Rheinübung* assuming that British radar was vastly inferior to their own.

At 1922 hours on the 23rd, the *Suffolk*, whose radar had a blind spot when another ship was directly astern, suddenly sighted the *Bismarck* and *Prinz Eugen* bearing down on her at a range of seven miles on the same course. She beat a hasty retreat into the fog banks, notified the *Norfolk*, and both ships began shadowing the Germans.

600 miles southeast of the German warships, so he would have to rely on the *Hood* and *Prince of Wales* to engage the enemy.

'We'll all get promotion
This side of the ocean
When we've sunk the old
Bismarck *and all'*
—ditty sung aboard
the *Prince of Wales*

At 0535, the *Hood* spotted the *Bismarck* with the *Prinz Eugen* leading about 17 miles off the starboard bow. At 0546, Admiral Holland issued the order for the two British ships to join battle head-on. Because of the vulnerability of his ship's armor to long-range fire, he wanted to get as close as possible before turning broadside to open fire with all his heavy guns. The decision to maneuver the two ships as a single unit, speeding into action only 800 yards apart, turned out to be a fatal mistake. The *Prince of Wales*'s

The Bismarck *and the* Hood

	Bismarck	Hood
Keel Laid	*1 July 1936*	*31 May 1916*
Commissioned	*24 August 1940*	*15 May 1920*
Displacement fully loaded	*53,500 tons*	*48,000 tons*
Overall length	*820 feet*	*860 feet*
Beam	*118 feet*	*104 feet*
Draft fully loaded	*30 feet*	*29 feet*
Top Speed	*30 knots*	*31 knots*
Crew	*2,200*	*1,419*
Guns	*Eight 15.4-inch* *Twelve 5.9-inch* *Sixteen 4.1-inch*	*Eight 15-inch* *Twelve 5½-inch* *Four 4-inch*
Armor	*40 percent of total weight*	*32.8 percent of total weight*
Deck:	*8 inches*	*3¼ inches*
Belt:	*12.5 inches*	*7 inches*

At 1939 hours, the *Hood*, about 300 miles due south, picked up one of the *Suffolk*'s reports and immediately changed course to intercept the German ships at dawn the following day. Admiral Tovey, in the *King George V*, picked up his first sighting report at 2032 from the *Norfolk*, which had come out of a fog bank to find herself right under the guns of the *Bismarck*. She quickly laid down smoke and disappeared into the fog, followed by straddling salvos of 15-inch shells. Some shrapnel landed on deck, but there were no direct hits. At this point, Admiral Tovey was

view of the enemy was reduced by the *Hood*'s funnel smoke and by the shell splashes thrown up around the flagship, and the *Hood* began the engagement by firing at the lead ship, mistakenly thinking it was the *Bismarck** when in reality it

* Originally, the *Bismarck* was in the lead; but the shock caused by her firing on the *Norfolk* knocked the forward radar out of action. *Prinz Eugen* was ordered to use her radar in the lead (they almost collided when passing), while the *Bismarck* positioned herself astern, covering the shadowing ships with her big guns.

was the *Prinz Eugen*. Both German ships concentrated their firepower on the *Hood*.

The battle was brief. At 0549, the *Hood* signaled for concentration of fire on the leading ship. At 0552, range 25,000 yards, the *Hood* signaled to "shift target right" onto the *Bismarck*. The first salvo from the *Bismarck* fell short of the *Hood*, but was close. At 0555, the *Bismarck* fired her third salvo, setting fire to ammunition on the *Hood*'s boatdeck. The *Hood* signaled for a turn to port to open full broadsides on the *Bismarck*. The fourth salvo from the *Bismarck* straddled the *Hood*. With the *Hood* and the *Prince of Wales* still turning at 0600, the *Bismarck*'s fifth salvo penetrated the *Hood*'s deck armor, reached a main magazine, and blew her up.

Nothing is here for tears;
nothing to wail
Or knock the breast; no weakness,
no contempt,
Dispraise or blame, nothing but
well and fair,
And what may quiet us in a death
so noble. —Milton

She split in two and sank immediately. But even as her bow half projected upwards, some of the *Bismarck*'s crew saw a bright flash of orange from the *Hood*'s forward guns. One last salvo!

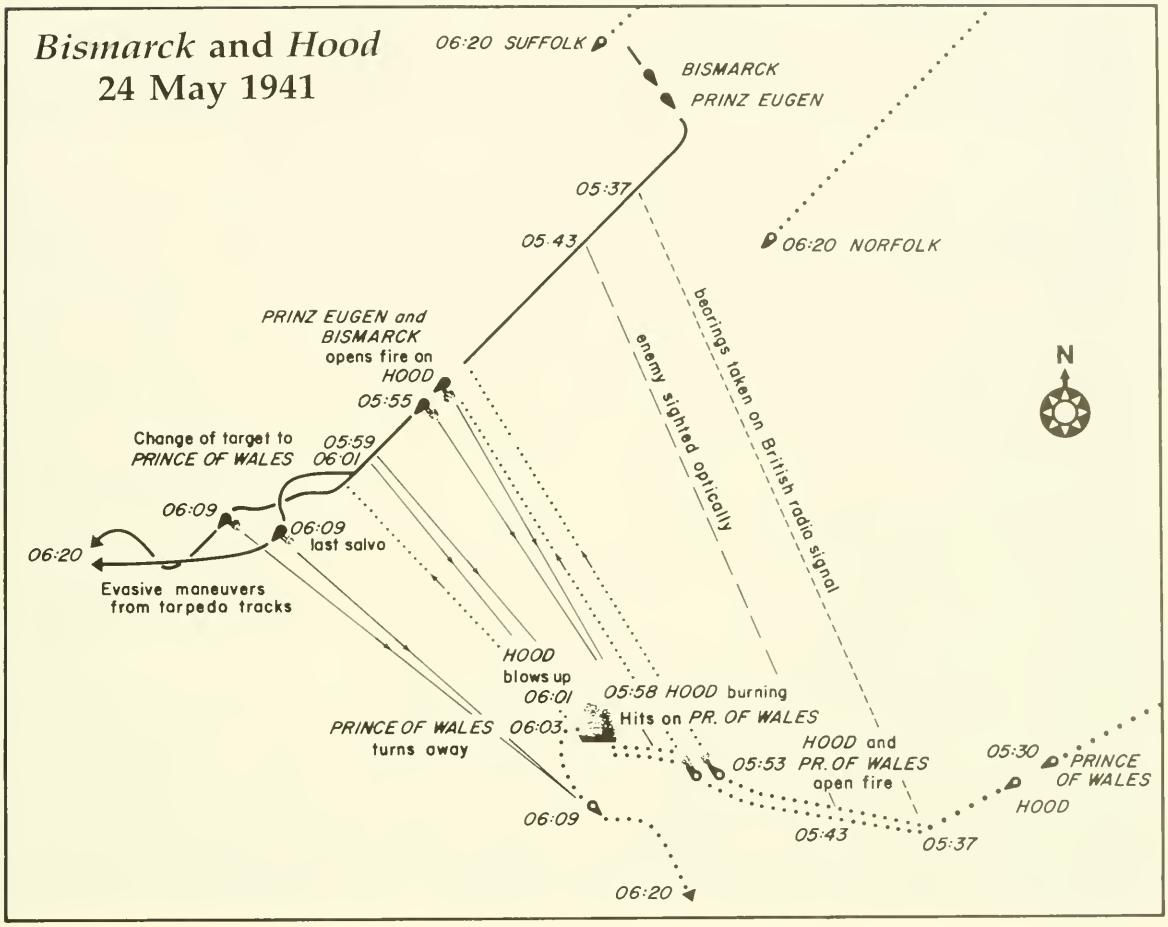
At 0602, the *Prince of Wales* received a bad hit on the compass platform, killing all crew members present except Captain Leach and a signalman. From 0606 to 0612, she was hit four times by the *Bismarck* and three times by the *Prinz Eugen*. At 0613, she broke off the battle and joined the *Suffolk* and *Norfolk* on shadow duty, but contact with the German warships was lost at 0306 hours on the 25th.

The *Prinz Eugen* escaped the battle without suffering any hits. The *Bismarck* suffered three hits from the *Prince of Wales*, one of which was to change the course of the *Rhein-übung* strategy. The hit from one British shell resulted in a flooded boiler room, dropping the German battleship's top speed from 30 to 28 knots, and another pierced a forward oil tank, causing the ship to trail an oil slick. This hit reduced *Bismarck*'s long-range capabilities, thus forcing her (because she was so powerful, Admiral Lütjens insisted on referring to the ship as "he") to seek port repairs. The Admiral rejected his Captain's advice that they return to Germany, arguing that they had already accomplished part of their mission by breaking out into the North Atlantic; and he guessed that the British Home Fleet would be deployed in the Denmark Strait awaiting his return. By afternoon, he had decided to send the *Prinz Eugen* to refuel and raid the British convoys while the *Bismarck* headed for France. The *Prinz Eugen* was allowed a clean break as her "big brother" turned around and fired on the *Suffolk*.

Around noon on the 25th, Lütjens spoke to the ship's company. According to surviving crew members, he said:

> *Seamen of the battleship* Bismarck*! You have covered yourselves with glory! The sinking of the battle cruiser* Hood *has not only military, but also psychological value for she was the pride of England. Henceforth, the enemy will try to concentrate his forces and bring them into action against us. I therefore released the* Prinz Eugen *at noon yesterday so that she could conduct commerce warfare on her own. She has managed to evade the enemy. We, on the other hand, because of the hits*

The battleship Bismarck*'s thundering salvos while engaging the* HMS Hood *in the Denmark Strait. The illusion of night is created by a time-exposure photo taken from the* Prinz Eugen.



we have received, have been ordered to proceed to a French port. On our way there, the enemy will gather and give us battle. The German people are with you, and we will fight until our gun barrels glow red-hot and the last shell has left the barrels. For us seamen, the question now is victory or death!

Admiral Lütjens initially believed he had not only sunk the *Hood*, but that the second ship was the flagship of the British Home Fleet, the *King George V*. It was not until later that same evening that he learned that the second ship he had beaten was the *Prince of Wales*.

At about 2330 hours, nine World War I-vintage Swordfish torpedo biplanes swooped down and attacked the *Bismarck* (box, page 16). One strike hit its mark, but caused only slight damage. The planes had taken off from the carrier *Victorious*, part of the Home Fleet.

Bismarck, *her bow down by about two degrees from flooding, after being damaged by* Prince of Wales, *24 May 1941. Taken from* Prinz Eugen.

American Catalina Pilot Spotted Bismarck

An American Navy pilot, flying as a special observer in a PBY Catalina on a search mission, was the first to spot the Bismarck *at 1030 hours on the 26th, reestablishing contact for the British Home Fleet, which had been searching for the German battleship for 31 hours.*

The sighting provided a definite fix on the battleship's location for the final attack. The American aboard was one of 17 sent to Britain to familiarize the RAF with the long-range reconnaissance capabilities of the American-built Catalina flying boat. The following observations of Ensign Leonard B. Smith have been excerpted from a declassified secret report provided by the the Operational Archives Branch of the Naval Historical Center:

Following a take-off at 0325 hours from Lough Erne, Northern Ireland, it was necessary to climb to 3,000 feet through overcast before proceeding to the west coast of Ireland. We took departure at 0430 from Eagle Island, altitude 500 feet on a westerly course. Weather conditions were undesirable, ceiling varying from 100 to 1,000 feet and visibility ranging from five miles to zero. The wind was 30 to 35 knots from the northwest, which reduced ground speed to approximately 80 knots.

The plane carried four depth charges (500 pounds each) and a capacity gas load (1,750 U.S. gallons). The trip to the assigned search area was uneventful other than several course changes that were necessitated by weather conditions. We arrived at our area at 0945 and immediately started to search.

Weather at the search area was somewhat better than that encountered on the trip out. Horizontal visibility below 800 feet was good—up to 8 or 10 miles. Misty conditions prevailed between 800 and 2,000 feet where the cloud lane covered five-sixths of the sky. Visibility between 800 and 2,000 feet was about four miles and at 2,000 about one or two miles.

At 1010 I sighted what was first believed to be the *Bismarck,* bearing 345 degrees at eight miles. Definite recognition was impossible at the time due to visibility. I immediately took control from "George" (the automatic pilot); I started a slow, climbing turn to starboard, keeping ship sighted to port, while the British officer, Flying Officer Dennis Briggs, went aft to

When the *Bismarck* managed to slip away from the shadowing British ships by circling away from their zig-zag course, Admiral Tovey's battle fleet was only 100 miles away. His first suspicion was that the *Bismarck* might sail west to harass the Halifax convoy route. The British admiral ordered the carrier *Victorious* to begin air searches at dawn on the 25th. He thought that the *Bismarck* might rendezvous with a tanker somewhere south of Greenland, refuel, and start raiding commerce.

Swordfish begin air search.

The British Admiralty had already transferred the carrier *Victorious* and the battle cruiser *Repulse* from convoy duty to Admiral Tovey's Home Fleet. There were 10 convoys plying the Atlantic at the time of the *Bismarck* breakout. In addition, Force H at Gibraltar, consisting of the battle cruiser *Renown*, the aircraft carrier *Ark Royal*, the cruiser *Sheffield*, and six destroyers were dispatched for the hunt, as was the battleship *HMS Revenge*, lying in Halifax harbor, Nova Scotia. On convoy duty hundreds of miles to the south, the battleship *Ramillies* was ordered to close and intercept. On the eastern side of the ocean, about 500 miles from the Irish coast, the battleship *Rodney*, escorting the *Britannic* to the United States along with four destroyers, including the *Mashona*, was ordered into the chase. The *Rodney*, with U.S. Navy Lieutenant-Commander Joseph H. Wellings aboard (article, pp. 20–26), was scheduled for a refit at Boston.

Thus, within six hours of the *Hood*'s destruction, two additional battleships, one battle cruiser, one aircraft carrier, three cruisers and

on 26th, Ending a 31-Hour Search

prepare a contact report. My plan was to take cover in the clouds, get as close to the ship as possible; make definite recognition, and then shadow the ship from the best point of vantage. On reaching 2,000 feet, we broke out of a cloud formation and were met by a terrific antiaircraft barrage from our starboard quarter.

We immediately jettisoned the depth charges and started violent evasive actions that consisted of full speed, climbing, and S turns. The British officer went aft again to send the contact report. When making an S turn I could see the ship was a battleship and was the *Bismarck,* which had made a 90-degree starboard turn from its original course (this was evident from the wake made by maneuvering) and was firing broadside on us.

The antiaircraft fire lasted until we were out of range and into the clouds. It was very intense, and were it not for evasive action, we would have been shot down.

The barrage was so close that it shook the aircraft considerably and the noise of the bursts could be heard above the propeller and engine noise. Numerous bursts were observed at close quarters and small fragments of shrapnel could be heard hitting the plane. A crew member came forward to the pilot's compartment saying we were full of holes.

As soon as we were well clear of the *Bismarck,* we investigated the damage, which consisted of a hole in the after port hull (about two inches in diameter) and one in the bottom of the hull directly below the instrument panel (about one inch in diameter). No other damage was visible at the time.

I made a short flight test (several turns, checked engines, etc.) and finding everything satisfactory, returned to area to resume shadowing of the *Bismarck.*

We could not find the ship the second time. According to reports that were intercepted from another Catalina, he was being attacked by enemy fire. We immediately set course to intercept him. We joined up with him and he was in contact with the *Bismarck.* We stayed in company for 45 minutes and then took departure for Lough Erne at 1530, the time specified by the Group Operations Officer. We landed at 2130 with approximately 250 to 300 gallons of gasoline remaining.

nine destroyers had joined the hunt. At 1810 on the 25th, the British Home Fleet, after committing a navigational error, was about 150 miles behind the *Bismarck*'s estimated position, and the Home Fleet's fuel supply was beginning to run low. In addition, the weather continued to be terrible—low clouds and high seas from the northwest.

At 1036 on the morning of the 26th, a Catalina flying boat of the RAF Coastal Command took off from Ireland with an American military observer aboard (box, above), sighted a warship through a break in the clouds, and circled to investigate. The *Bismarck* put up a furious round of antiaircraft fire, but after 31 hours of lost contact, the British now knew definitely where she was—690 miles from Brest.

Admiral Tovey was now 130 miles to the north, with a critical fuel situation. Within 24 hours the *Bismarck* would be under the air umbrella of the Luftwaffe and in the protection of German submarines. The *Prince of Wales* and *Repulse* were out of the hunt, having been ordered to return home for refueling. The only hope for slowing down the *Bismarck* lay in the Fleet Air Arm, which was on the carrier *Ark Royal* approaching from the south with Force H.

A Catalina flying boat on patrol.

The Swordfish and the Modoc

Swordfish parked on Victorious's *flight-deck in readiness to attack* Bismarck. *"The nine planes were squatting at the end of the flight-deck like a covey of damn partridges," an observer commented.*

At 2000 hours on the night of 24 May 1941, nine torpedo-carrying Swordfish biplanes—holdovers from World War I—and two escorting Fulmar fighters took off from the pitching deck of the carrier Victorious. *This hazardous launch marked the first time aircraft left a carrier to attack a German battleship at sea.*

This episode in the Bismarck *saga, however, really begins on 21 May. On that day, the U.S. Coast Guard cutter* Modoc, *under the command of Harold G. Belford, was dispatched to search for survivors of a destroyed convoy 150 miles southeast of Cape Farewell, the southernmost tip of Greenland. On the 23rd, they searched east of their original position. On the 24th, they moved even farther eastward to make certain there were no more survivors. A northwestern gale blew the entire day, resulting in poor visibility. At about 2030 that night, the* Modoc *received an urgent message that it was in the area of a bombing attack.*

At about 2330 Lieutenant Commander Eugene Esmonde and his squadron of Swordfish passed over the shadowing cruisers Norfolk *and* Suffolk *and streaked off in the wrong direction. The* Norfolk *called them back on course. Shortly thereafter, the planes picked up an appearance of the* Bismarck *on their radar. They broke cloud formation and fell into attacking formation. Diving down on what they thought was the enemy, they pulled away just in time—for instead of finding the massive* Bismarck, *they found only* Modoc.

The Bismarck *was not far off, and soon the Swordfish were on their destined course; this faulty attack, however, gave German antiaircraft batteries time to prepare. They unleashed a great mass of flak, some of which whizzed dangerously close over the* Modoc's *port bow. But that was not the end of the American cutter's problems. For shortly after the fliers left, the bridge of the* Norfolk *sighted another battleship through the mist. Who was it? The Captain saw turrets and the distinctive battleship outline. He ordered hard to port. The* Norfolk *pulled around and signaled to the* Prince of Wales *to open fire immediately. The British battleship held its fire and signaled back that it was not sure the sighting was of the* Bismarck. *Fortunately for the* Modoc, *the* Prince of Wales *was right.*

Again the Swordfish plummeted from the clouds, and attacked the Bismarck.

"The [aircraft] were moving so slowly that they seemed to be standing still in the air, and they looked so antiquated. Incredible how the pilots pressed their attack with suicidal courage, as if they did not expect ever again to see a carrier," observed surviving gunnery officer Burkard von Müllenheim-Rechberg. The Swordfish attacked from all directions, some only two meters above the water, waiting until they were within 400 to 500 meters before unloading their torpedoes.

In the end, only one scored, sending a warrant officer crashing into a wall or a deck—the Bismarck's *first fatality. Amazingly, all the Swordfish returned to the* Victorious *safely, but the two Fulmar fighters ditched in the sea and were lost.*

The one torpedo hit landed amidship where the armor was thickest, causing little direct damage. However, when the Bismarck *increased her speed, the water pressure increased as well; this, along with zig-zagging to avoid torpedoes, reopened the hole in the forecastle caused earlier by the* Prince of Wales. *The bow took on water and sunk deeper. The* Bismarck *had to reduce its speed to 16 knots to repair the wound. The Swordfish had succeeded in their mission: to slow down the* Bismarck, *so that Admiral Tovey's net of warships could tighten.*

The first attack by torpedo-carrying Swordfish planes, at 1450 hours on the 26th, was a near disaster. They mistook the *Sheffield*, which had been detached from the Home Fleet to locate the German battleship, for the *Bismarck*. The weather conditions were still very bad, and fortunately the magnetic firing pins on the torpedoes had been improperly set. Some blew up on contact with the water and the *Sheffield* evaded others. *Ark Royal*'s captain sent an uncoded message: "Look out for *Sheffield*." On realizing the mistake, the disheartened flyers returned to ship.

With daylight running out, 15 Swordfish launched a second strike in an all-out, last-ditch attempt to stop the *Bismarck*. Braving murderous fire from the *Bismarck*'s guns, one of the Swordfish managed to put a torpedo into the *Bismarck*'s steering gear, jamming her rudder hard over. No planes were lost. The pride of the German fleet was limited to a speed of only 10 knots and, putting her stern away from the pounding seas, was now headed straight for the pursuing British Home Fleet. The Swordfish had found the *Bismarck*'s Achilles' heel.

"One torpedo which hit amidships caused no damage," Gerhard Junack, a surviving engineering officer recalled, "but the second affected the rudders disastrously by jamming the portside rudder at a 15° angle. Immediately the *Bismarck* became no longer maneuverable. The torpedo hit on the rudder shook the ship so badly that even in my zone of action in the turbine room the deck plates were thrown in the air and the hull vibrated violently. . . .The stern compartments in the ship were now flooding, but the men who had been stationed there could still be saved and soon the carpenters and repair crew came through making their way aft. . . eventually it was found possible to connect the hand rudder. But the old rudder would not budge and to attempt to cut it away with underwater saws was quite impossible because of the heavy swell. A proposal to force the rudder out from below with the help of explosives was rejected because of the proximity to the propellers." The damage, Admiral Lütjens concluded, was irreparable. But the *Bismarck*'s guns were undamaged. Hitler sent a message to the crew of the *Bismarck*: "The whole of Germany is with you. What can still be done will be done. The performance of your duty will strengthen our people in the struggle for their existence."

All through the night, until 0700 hours on the 27th, British destroyers made attack after attack on the *Bismarck*, keeping the German ship's exhausted gun crews holed up at their stations. The destroyers, however, were driven off time and again by the *Bismarck*'s thunderous salvos. At 0800, the *King George V* and *Rodney*, which had 14-inch and 16-inch shells, closed to a range of about 16,000 yards in heavy-running seas; and at 0847 the final battle was joined.

The British official history states: "Gradually the range was reduced to what can justly be described as point-blank target practice. By 1015 the giant battleship had been reduced to a flaming shambles."

Hatches and doors wrenched from their hinges littered the decks, according to survivors. The red glow of fires illuminated the darkened passages and thick smoke and fumes from bursting shells poisoned the atmosphere and poured from great holes six feet wide blasted in the upper deck. Listing to port and wallowing in the trough of the Atlantic swell, the once-pride of the German navy was now a black and burning hulk.

"Gradually," Junack commented, "the noise of combat became more irregular until it sank, to become nothing more than a series of sporadic crashes; even the control bells from the bridge stopped ringing. All three turbine rooms were filled with smoke from the boiler room; fortunately no shells had yet come through the plating protecting the engine room or the electric generators. . . .Somewhere about 1000 hours I received an order over the telephone from the Chief Engineer: 'Prepare the ship for sinking.' That was the last order I received on the *Bismarck*. After that all transmission of orders collapsed."

At 1015 on the 27th, Admiral Tovey signaled to the *Rodney* to form astern and break off the engagement. He was headed home. He signaled that any ship nearby with torpedoes was to finish her off. This the *Dorsetshire* did. She fired two from her starboard side, then circled around the target and fired one more. At least two torpedoes scored. Even so, the *Bismarck* was helped on her way by German engineers, who had ample time to prepare scuttling charges. The *Bismarck* rolled over and sank at 1036 hours, her flag still flying, her screws still turning. Admiral Lütjens was reported killed during the action and

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But only agony, and that
has ending; And the worst
friend and enemy is but Death.
—Rupert Brooke

Captain Lindemann, still alive, gallantly chose to go down with his ship.

Some 800 German sailors abandoned ship, but there were only 115 survivors. Most of the sailors were picked up by the *HMS Dorsetshire*, which broke off rescue operations when it spotted what was believed to be a U-boat periscope.

The following is the abbreviated text of Admiral Tovey's letter of congratulations to the Home Fleet after the sinking of the *Bismarck*. It was provided by the Operational Archives Branch of the U.S. Naval Historical Center as a declassified secret document.

I wish to congratulate the Home Fleet on their part in the sinking of the Bismarck,

Into the Water. . .

About 0600 on 27 May, a stand-easy was ordered aboard the Bismarck. *I do not know for what reason. She had a slight list to port. Heavy seas. The waves came up to the upper deck.*

During the stand-easy it was piped: "All nonduty officers into the charthouse." Immediately afterward, action stations were sounded. Nothing could be seen of the enemy. It was said that smoke clouds had been sighted. Before our own guns fired, enemy shells dropped close to the ship.

After about one hour, the first hits were scored on our ship. I myself was wearing the telephone. The connection broke off. I took off the telephone. From this time onward, no orders were given by the antiaircraft control to my gun. As the hits increased the antiaircraft crews went under cover. We had the impression that we were fired at from all sides.

First, I was with a group of 20 men in the aft gunnery position. After a few hits close by we fled behind the turrets C and D on the upper deck. Before that we threw five or six rafts on the deck below and went with the rafts behind the turrets. Through a hit, all rafts except one or two were destroyed. We now had several injured. At this time turret D was still firing. At this time my comrade Herzog came to me. We saw a raft between turrets C and D. With the help of several others, we released and pulled it behind turret D. There, several comrades left us. Through a hit and a wave, the raft and three of us were thrown overboard. We all three swam toward the raft.

We only succeeded in reaching it after about 15 minutes as hit after hit landed in the water. Nearby, another raft was drifting with one injured and five or six other comrades. In the raft, we drifted astern. The ship herself we only saw when we were on top of a wave. Once I saw the Bismarck *was getting a list to port. It appeared that the ship had made a little way to port. Shortly afterward, I no longer could see the* Bismarck, *but only a smoke cloud. I did not hear an explosion. Not far from us I saw two cruisers making toward the place where* Bismarck *was. These cruisers were firing.*

which may have an effect on the war as a whole out of all proportion to the loss to the enemy of one battleship.

To mention individuals may be invidious, but we have to thank the crew of the aircraft from Hatson for their daring reconnaissance of Bergen, which started us off on this long chase, and the crew of the aircraft from Victorious *which, by scoring a torpedo hit on the evening of 25th May, went a long way to giving other ships their opportunity.*

What was particularly satisfying to me was the almost uncanny way in which all ships and commands operated exactly as I wished them to without the necessity for any signaled instructions from me . . .

Invaluable work was done by Force H on the 26th May in providing the excellent reconnaissance and carrying out a most successful [torpedo-bomb] attack which ensured the Battle Squadron having their opportunity the next morning. The Fourth Destroyer Flotilla carried out a most successful torpedo attack and their most accurate shadowing was of the greatest assistance . . .

The King George V *and* Rodney *did terrible damage to the* Bismarck, *and the* Rodney *has the satisfaction of being, as far as I know, the only capital ship ever to hit another with torpedoes.*

I particularly wish to congratulate the Engine Room departments of all ships on their maintenance of high speeds over such an unusually long period. The speed and accuracy shown by the communication and cypher staffs in dealing with the heavy and continuous traffic also deserves mention.

—Jack C. Tovey
Admiral
Commander-in-Chief
HMS King George V
28th May 1941

Had she [the* Bismarck*] escaped, the moral effects of her continuing existence, as much as the material damage she might have inflicted on our shipping, would have been calamitous. Many misgivings would have arisen regarding our capacity to control the oceans, and these would have been trumpeted 'round the world to our great detriment and discomfort.

—Winston Churchill
The Second World War, *(Vol. III)*

The loss of the* Bismarck *had a decisive effect on the conduct of the war at sea.

—Grand Admiral Erich Raeder
Commander-in-Chief of the German Navy
Struggle for the Sea

□

. . .Into the Water

We had nothing to eat or drink in the raft. The other raft, which in the beginning had been near us, had gone out of sight. I do not know what time we were washed overboard. When the sun was directly over us and we had practically given up all hope of being rescued, we sighted a "Kondor" or FW 200. We waved to it, but could not determine whether we had been seen.

We felt tired. My comrade Herzog had been injured in the foot. In the evening, shortly before 1900, a U-boat suddenly surfaced close to us. We were taken on board and immediately packed into bunks and fed. The U-boat—she was U 74—searched for two days for survivors. Only corpses and wreckage were sighted.

—**Herbert Manthey**
Ordinary Seaman aboard the *Bismarck*

(British Imperial War Museum Photo)

U.S. Navy Captain's Tale of *Bismarck*'s Final Days

During the summer of 1940, when Britain was besieged by Hitler's war machine, then-Captain Joseph H. Wellings of the U.S. Navy was sent to Britain as an observer of the British Home Fleet, with additional duty as assistant naval attaché in London.

Interested in the operational aspects of the Royal Navy's forces, he served as operations officer on the HMS Rodney *during her convoy escort duty in the fateful period that included the* Bismarck*'s final days.*

Wellings had a distinguished career in the Navy, retiring as a Rear Admiral in 1963. His last assignment was Commandant of the First Naval District, which included naval bases at Boston, Massachusetts, and Portsmouth, New Hampshire.

Awarded the Bronze Star, the Silver Star, and the Gold Star, Wellings died in 1988 at his home in Newport, Rhode Island. He was one of four brothers, all of whom became Rear Admirals in the U.S. Navy. He graduated in 1925 from the U.S. Naval Academy and attended Harvard Law School. He was married with one daughter.

The following are adapted excerpts from his personal diary and reminiscences as they appear in On His Majesty's Service, *edited by John B. Hattendorf, courtesy of the Naval War College, Historical Monograph Series No. 5:*

Joseph H. Wellings

Personal Diary, 21-24 May 1941

21 May—Arrived in Glasgow at 0630. Arranged for a truck to transfer baggage & pouch mail to Greenock. Very accommodating. Was also supplied with an auto plus a Wren chauffeur to drive *me* to Greenock. Had breakfast at Bay Hotel in Gaurock, then went to office where I was told where to unload baggage & pouch mail for the *Rodney*. Given a special boat. Arrived on board at 1145. Russell & Cooke from *Eskimo* waiting for me. *Repulse, Exeter, Argus, Brittanic* plus 5 tribal destroyers also in harbor. Nap in P.M. then over to the *Eskimo* for dinner—good to see the destroyer crowd again; stayed until 0200. Anne's (daughter) birthday today—wish I were home.

22 May—Slept in until 0900. Exec. quite concerned over keeping the boat late—apparently the *Eskimo* ordered a boat from *Rodney* to call for me and thereby interrupted their boat schedule. I knew nothing about it. Thought the exec. was a little too worried about the entire matter. Personally I think he used very poor judgment in making a fuss about it. *Underway* at 1230—Homeward bound. Speed 18, *Brittanic* astern 5 destroyers as a screen. Passed through North channel at 1700. Course 300. Captain spoke over ship's radio—We are due in Halifax on 29 May and perhaps sail for Boston same day. Have not met

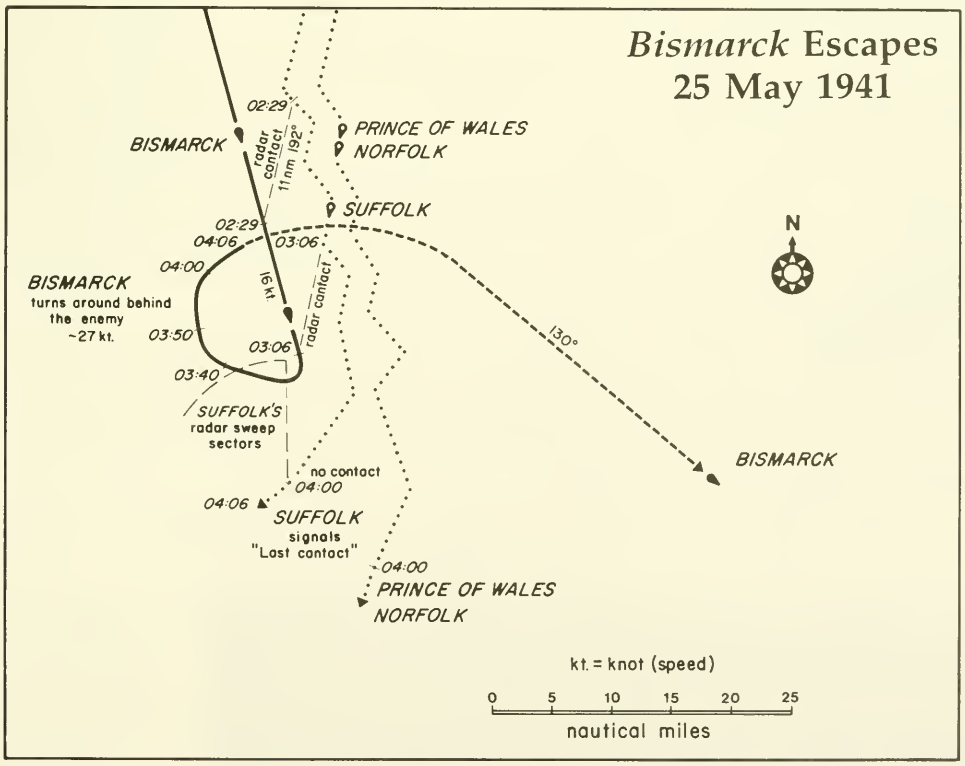
Captain as yet—it seems kind of odd.—Talked with Kenneth Downey & Captain Coppinger new skipper of *Malaya* until 1030 P.M. then to bed. Have a comfortable cabin—inside one. All pouch material stowed away under lock and key plus sentry.

23 May—Underway with *Brittanic* and 4 destroyers bound for Halifax. Weather overcast, sea fairly rough. Slowed to 13 knots at 0900—too rough for destroyers. Talked with Miller and Herwitz our two Chief Petty Officers who are returning to U.S. in *Rodney*. Read & [I] talked with Captain Coppinger after lunch. He seems to be a good sea dog but very odd in many ways. All hands asking me about Boston after Captain of *Rodney*, Dalrymple-Hamilton, officially announced Boston as our final destination. At 2240 Captain announced over loud speakers that two German combatant ships had been sighted trying to break through between Iceland and Greenland.—Dolly & my monthly anniversary. Thought I would be home for this one.—Oh well it will not be long now.

24 May—A little rough—Kenneth Downey & Gargon—Frenchman a little sick. We have a total of 512 passengers aboard. Contact last night was made by *Suffolk* & *Norfolk*. German ships are *Bismarck* & *Prinz Eugen*. *Norfolk* & *Suffolk* still trailing. At 0553 this morning *Hood* & *Prince of Wales* engaged *Bismarck* & *Prinz Eugen*. *Hood* sunk at 0600, *Prince of Wales* damaged slightly or perhaps more so. At 1200 *Rodney* left *Brittanic* and with 3 of the 4 destroyers as screen changed course to the west ahead of the *Bismarck*. Everyone getting excited about possibility of making contact. I spent most of the day reading signals with Gallica. At 2030 planes (9) from *Victorious* made a torpedo attack on *Bismarck*—one hit which did not slow the *Bismarck*.

Reminiscences, 25 May 1941

When Lieutenant Commander Gatacre and I read the *Suffolk* 0401 message at about 0420 saying she had lost radar contact with the *Bismarck* we became concerned over the *Bismarck's* probable course of action, and began immediately to make a summary of the situation. Captain Dalrymple-Hamilton arrived in the chart house shortly thereafter and called our full Operations Committee into session. Our summary of the situation indicated



the *Bismarck* was headed for a Bay of Biscay port, probably Brest rather than St. Nazaire, because under the present unfavorable weather conditions Brest offered a much easier and safer entrance. Our decision was based on the following factors:

a. The *Bismarck* received some damage in her battle with the *Hood* and *Prince of Wales* as evidenced by her trailing oil, and a reduction in speed after the battle.

b. The hit by the *Victorious* torpedo aircraft may have compounded this damage.

c. A return to Germany via the Denmark Strait and Norwegian Sea, or via the Iceland Faroes Passage and the Norwegian Sea was too dangerous.

d. Repair facilities were available in the general Brest and St. Nazaire areas. In addition the overhauls of the battle cruisers *Sharnhorst* and *Gneisenau* at Brest were about completed.

e. German aircraft, submarines and surface craft (mainly destroyers) could easily provide air, submarine and surface protection to the *Bismarck* within about 400 miles of the western coast of France.

I remember distinctly my strong arguments in favor of the above decision. I believed without any doubt, the *Bismarck* was headed for a Bay of Biscay port, but I desire to reiterate that in many cases strategic decisions are not too difficult when you have all the factors bearing on the problem and the overall responsibility does not rest on your shoulders. Captain Dalrymple-Hamilton who bore all the *Rodney* responsibility listened to our discussions, asked several questions, and made the final decision to stay in the vicinity of our 0800 position for the time being and then act on the assumption the *Bismarck* was headed for a Bay of Biscay port if she were not sighted within the next two or three hours.

Personal Diary, 25 May 1941

...Still holding on to a westerly course. *King George V* should be the one to make contact at 0900—At 0306 *Norfolk* & *Suffolk* lost contact. A search was organized. We changed course to about 060° to intercept if she headed for Brest. At 1330 D/F [direction-finder] bearings gave an indication of *Bismarck*'s position. We steamed east (060°) until we got on a line with this position and Brest then headed towards Brest (120°). No further word of *Bismarck*. Will she get through. All kinds of excitement.

Reminiscences, 25 May 1941

...We were very much surprised to read a message from the Commander-in-Chief Home Fleet shortly after 11:00 A.M. which said:

"By radio direction-finder bearings estimate enemy position at 0952/25 was latitude 57° North, longitude 33° West. All Home Fleet units search accordingly." This message had a time of origin of 1047/25. Our surprise, of course, was due to the fact our plotted position of the ship as indicated by the radio direction-finder bearings was about sixty miles south of the position stated by the Commander-in-Chief Home Fleet. We checked the navigator's position and believed his position to be correct.

The Commander-in-Chief's Home Fleet message of 1047/25 was the unfortunate message which sent all the Home Fleet units except the *Rodney*, and perhaps the *Edinburgh* and *Norfolk* on the wild goose chase north and northwestward for about seven critical hours while the *Bismarck* was steaming southeastward toward Brest at 20–22 knots.

Captain Dalrymple-Hamilton thought the Admiralty would send a correction to the Commander-in-Chief's 1047/25 message.

The Commander-in-Chief's Home Fleet message of 1047/25 created a very difficult situation for Captain Dalrymple-Hamilton. Should he direct the *Rodney* to remain in the general area of our 0900 A.M. position? Should he order the *Rodney* to steer a course which assumed the *Bismarck* was returning to Germany via the Denmark Strait or the Iceland-Faroes Passage? Should he steer a course to arrive in the shortest possible time at the intersection of the track between the *Bismarck*'s last reported position at 0200/25 by the *Suffolk* and Cape Finisterre? And if the *Bismarck* was not sighted within a reasonable time after passing through this intersection, then alter course to cross the *Bismarck*'s track in the shortest possible time, on the assumption she was headed for Brest from her last reported [position] by the *Suffolk* at 0200/25?

Captain Dalrymple-Hamilton's firm belief that the *Bismarck* was headed for a Bay of Biscay port resulted in his decision to leave our general area, and direct the *Rodney* to steam toward the intersection of the track between the *Bismarck*'s last reported position at 0200/25 and Cape Finisterre. The *Rodney* altered course to 030° at 11:40 A.M., increased speed to 17 and then gradually to 20 and 21 knots. Captain Dalrymple-Hamilton, Lieutenant Commander Gatacre and I were extremely happy to receive an Admiralty message to the *Rodney* at 1158/25 which said: "Act as though the enemy is proceeding to a Bay of Biscay port."

The Admiralty also sent the following message to a number of shore stations at 1200/25. The *Rodney* intercepted and decoded this message which read: "The Admiralty believes the *Bismarck* is headed for Brest."

When the *Bismarck* was not sighted by 4:20 P.M. Captain Dalrymple-Hamilton, after consultation with Lieutenant Commander Gatacre and Commander Grindle, altered the *Rodney*'s course to 055° in order to cross the *Bismarck*'s track in the shortest possible time on the assumption she was headed for Brest from her last reported position by the *Suffolk* at 0200/25.

When the *Bismarck* was not sighted by 9:00 P.M. Captain Dalrymple-Hamilton ordered the *Rodney* to change course to 118°, as we headed toward Brest at a speed of 21 knots.

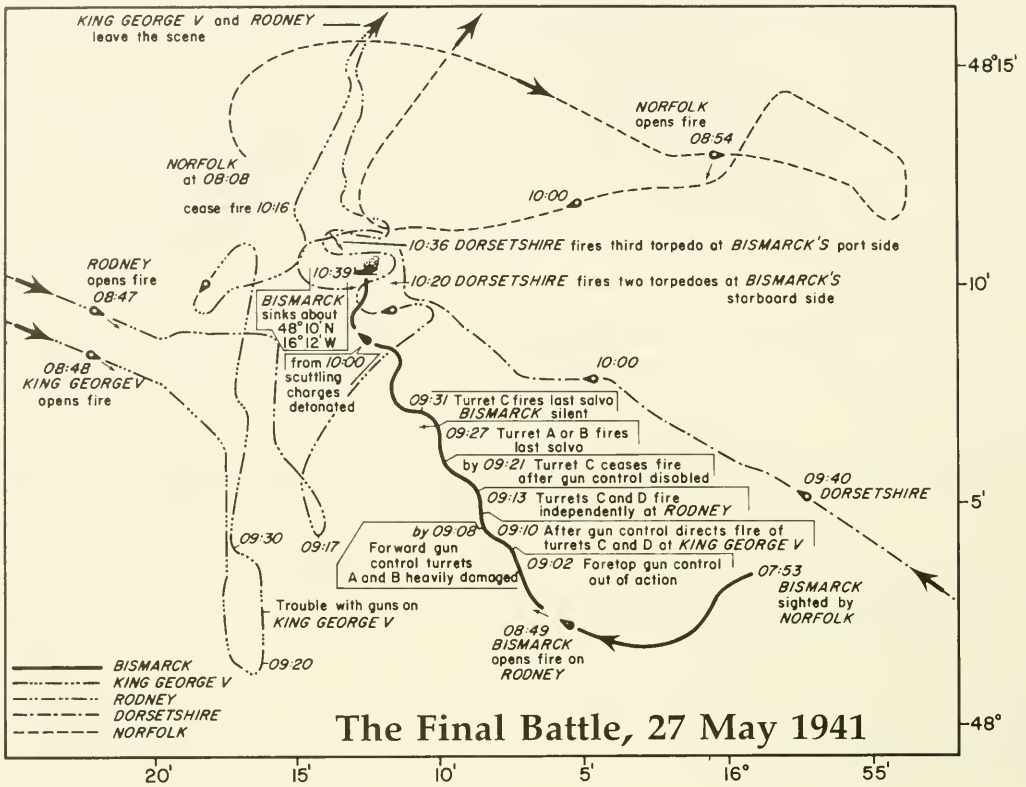
Personal Diary, 26 May 1941

...Steaming as before looking for *Bismarck*. At 1030 Catalina flying boat sighted *Bismarck*—about 110 miles bearing 200 from *Rodney*. Continued on our course. At 1700 *King George V* (K.G.V) joined. *Ark Royal*'s planes sighted *Bismarck*—torpedo attack at 1500 unsuccessful. Another attack at 2100 produced one & perhaps 2 hits. After this attack *Bismarck* made two complete circles then headed north, the only possible action she could take if we are to intercept. We headed south. Dark at 0100—Commander-in-Chief decided to wait until morning to attack.

Personal Diary, 27 May 1941

Destroyers attacked (3 destroyers made independent attacks) 2 hits claimed. At sunrise—weather cloudy. Destroyers still shadowing. At 0708 we headed for *Bismarck*. Sighted *Bis* at 0843. At 0847 we opened fire. 1–15" later *King George V* opened fire. *Bismarck* & ourselves closed 27 minutes later. *Bismarck*'s fire erratic. We closed to 2750 yds. & continued to fire silencing *Bismarck*. At 1039 *Bismarck* sank. *King George V* & ourselves headed north— Big show over. Second *Bismarck* salvo fractured hull above armor plate and at superstructure just forward of bridge particularly the forward antiaircraft control area. Fortunately no one injured. How lucky we were, if the second salvo landed about 20 yds. further aft our entire bridge structure would have been pierced & probably wrecked with the captain and other key personnel.... The executive officer

The Rodney *firing on the* Bismarck.
(British Imperial War Museum Photo)



would be C.O. & yours truly ... would assist him in accordance with Capt. Dalrymple-Hamilton's desires.

Captain Dalrymple-Hamilton presented me with *Rodney* plaque...in afternoon saying many thanks Wellings for all your assistance during an eventful week.

*Statement of Chief Petty Officer Miller, USN**

Damage Sustained from Enemy Action

The ship received four (4) hits—all 5.9" shells.

Damage from these hits were very minor, no structural damage being sustained whatsoever.

One (1) hit in H.A. Director, causing a small hole in the bulkhead—no damage.

One (1) hit in the starboard Marine compartment, causing a 6" hole in the starboard side of the ship—above waterline—no damage.

One (1) hit in a stateroom just abaft of the conning tower, causing a small hole by splinter—no damage.

One (1) hit in the CPO mess, starboard side, causing a 6" hole, above the waterline—no damage other than to three lockers containing personal clothing.

Self-inflicted Damage

Damage sustained from contusion of broadsides was very considerable, causing undue discomfort to the personnel and much work on their part to make compartments habitable.

Tile decking in washrooms, water closets and heads were ruptured throughout the ship. Urinals were blown off bulkheads, water pipes broken, and heads flooded.

Longitudinal beams were broken and cracked in many parts of the ship having to be

*Miller was a passenger on *HMS Rodney* returning to the United States.

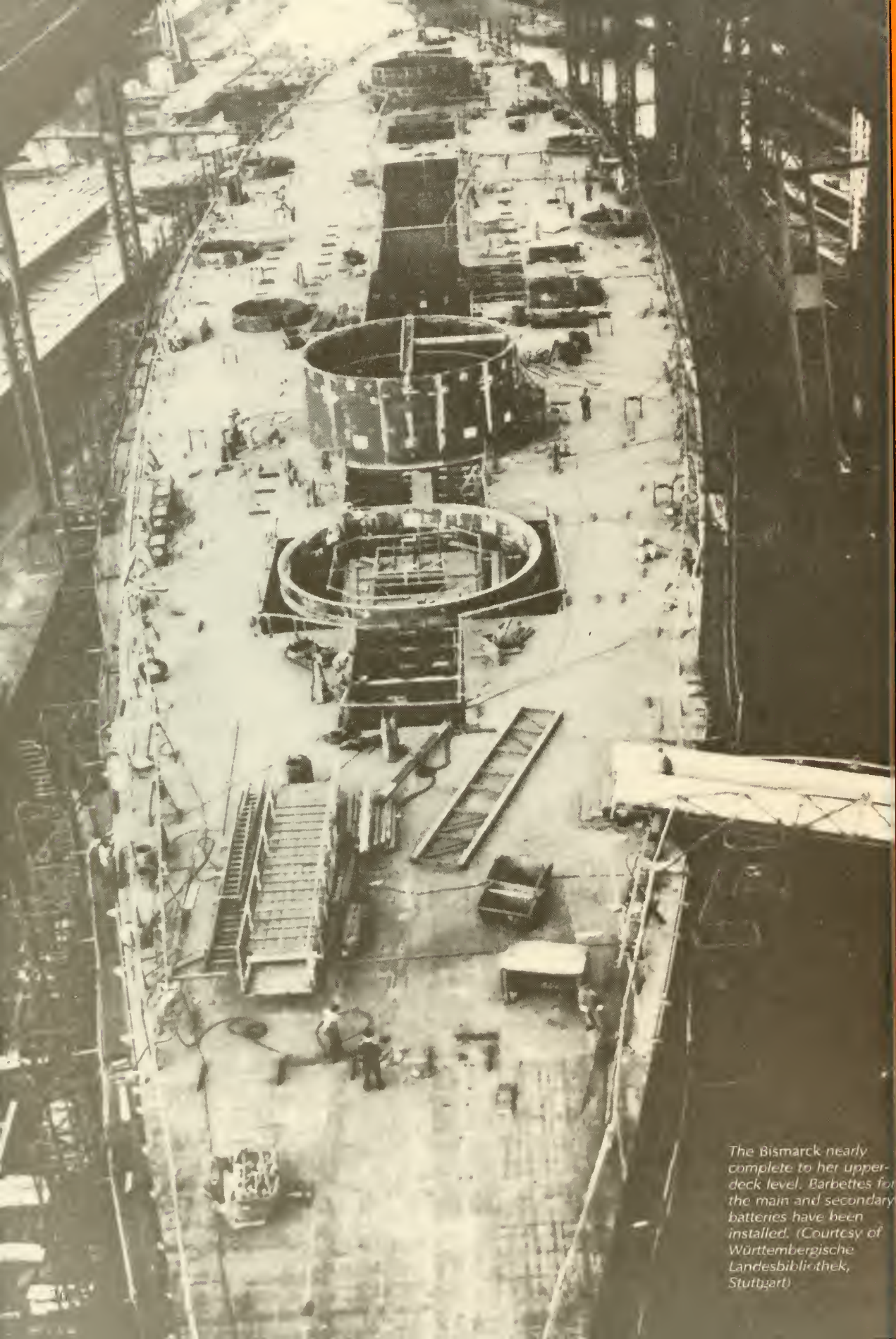
shored. (Note: ship constructed with longitudinal beams instead of athwarthships as is the case in practically all ships.) The overhead decking ruptured and many bad leaks were caused by bolts and rivets coming loose. All compartments on the main deck had water flooding the decks. The British navy does not use swabs but wet rags to mop up any excess water, not only requiring considerably more man hours but also not accomplishing as efficient a job as a swab.

Cast iron water mains were ruptured and in many instances broke, flooding compartments.

Electric lighting in compartments was left on during the action. All electric lights were disintegrated and bulbs and sockets snapped off the leads causing live wires to be existent throughout the ship.

Bulkheads, furniture, lockers and fittings were blown loose causing undue damage to permanent structures when the ship rolled.

HMS Rodney, *a Nelson-class battleship, launched 17 December 1925 by Cammell Laird; length overall 710 feet; beam 106 feet; draft 28½ feet; speed 23 knots; displacement 33,900 tons; Armament: nine 16-inch, twelve 6-inch, six 4.7-inch antiaircraft, twenty-four 2-pounder (shell weight) antiaircraft, twelve machine guns, two 24.5-inch torpedo tubes, two aircraft. Served Home Fleet, 1939–42; Force H, 1943; Home Fleet 1943–45; Scrapped 1948. (Courtesy of the Naval Historical Collection, W.L. Mullin Papers)*



The Bismarck nearly complete to her upper-deck level. Barbettes for the main and secondary batteries have been installed. (Courtesy of Württembergische Landesbibliothek, Stuttgart)

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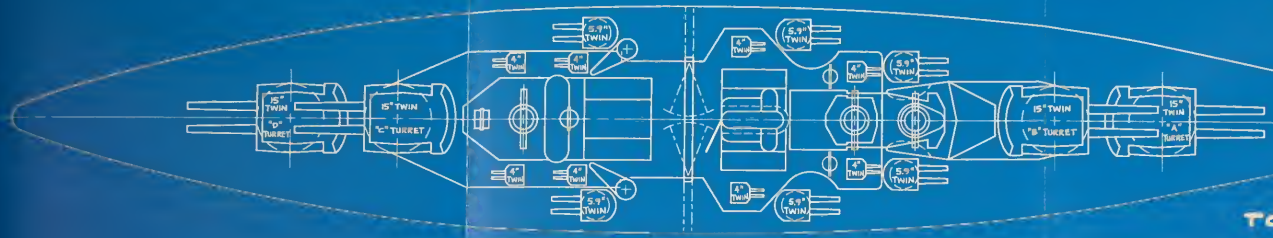
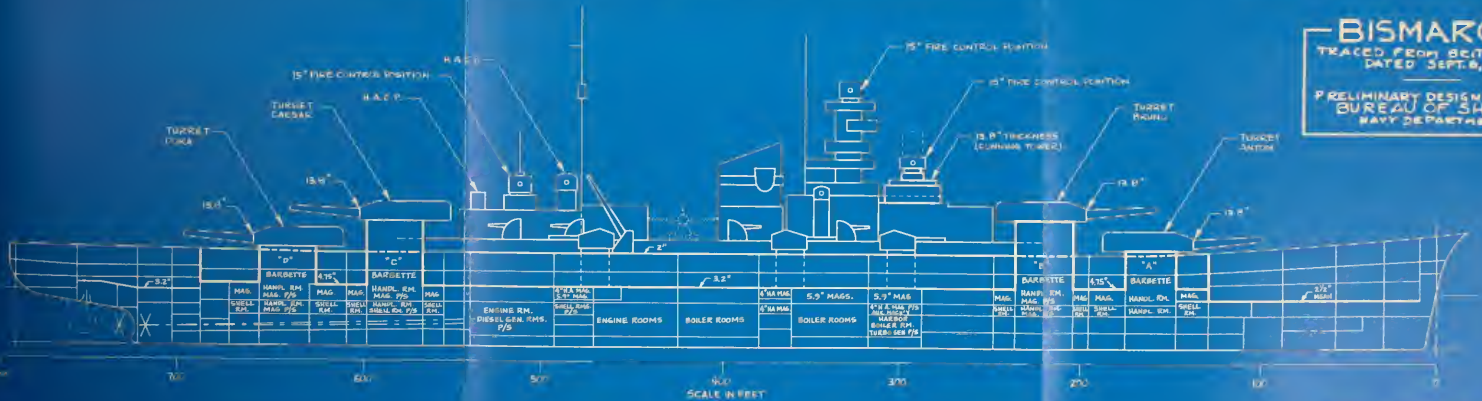


TOPSIDE PLAN

BISMARCK

TRACED FROM BRITISH PLAN DATED SEPT. 8, 1941

PRELIMINARY DESIGN BRANCH
BUREAU OF SHIPS
NAVY DEPARTMENT

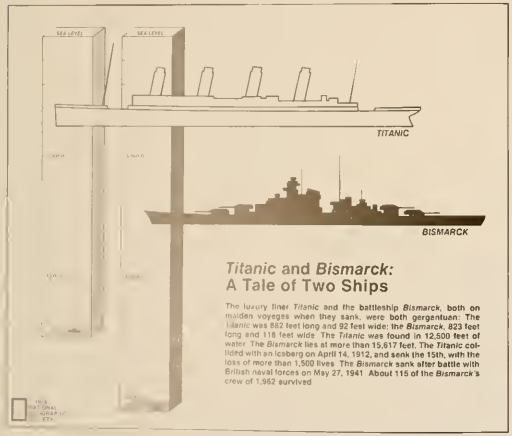


PROFILE

The ship's badge was the coat of arms of the Iron Chancellor, Otto von Bismarck

An antiaircraft gun points over the wreck of the Bismarck. During the battleship's last days, its batteries fired at British reconnaissance planes and Swordfish biplanes. (© 1989 National Geographic Society)

The aft fire-control station from which the highest-ranking survivor, Third Gunnery Officer Baron von Müllenheim-Rechberg, directed gun turrets Caesar and Dora. (© 1989 National Geographic Society)



Ballard (in jumpsuit) helping haul Argo aboard. On this occasion, hundreds of yards of black polypropelene of unknown origin were entangled around the back of the vehicle. (Photo by Jack Maurer)

Ballard directs a photographic survey of the Bismarck from the control room of the Star Hercules by monitoring images sent from the deep-sea robot Argo. (© 1989 National Geographic Society)

"I was surprised to find the Bismarck *sitting upright, proudly on the bottom. We found no human remains. We touched nothing and took nothing."*

—Robert D. Ballard, 22 June 1989, Press Conference, Washington, DC

The Quest to Find the *Bismarck*—1988/89

June 8, 1989, 0959 hours: British ship *Star Hercules* spots German battleship *Bismarck*. But there are no fearful lookouts peering through binoculars. Instead, eager oceanographers are scanning video monitors, watching images sent up from the dark depths three miles below. After 48 years in the cold bottom waters of the North Atlantic, the *Bismarck* comes under the floodlights of Argo, the undersea robot that three years ago found the broken hull of the British liner *Titanic*, lost in 1912.

The modern search for the *Bismarck* actually began in July 1988. After completing a foray into the Mediterranean to look at ancient Roman wrecks, Robert D. Ballard of Woods Hole Oceanographic Institution (WHOI) conducted his first expedition to find the supposedly invincible World War II battleship. The cry was "Find the *Bismarck*!" They found no sign. With continued funding from National Geographic, the Quest Group, and Turner Broadcasting System, the underwater explorer returned in May 1989 to the reported sinking site of the *Bismarck*.

The bow of the Bismarck. *(All photos in this section ©1989, courtesy of National Geographic Society)*

Ballard was inspired largely by his heritage—both German and English. Also, he was intrigued by parallels in the fates of the *Bismarck* and the *Titanic*. Both the largest ships of their time, they were considered unsinkable. The *Titanic* sunk on her maiden voyage, the *Bismarck* on her first campaign. In each case, their watery graves are more than two miles deep. Finding the German warship would prove the discovery of the *Titanic* had been no accident, and validate the $3.2 million spent during the last seven years by the Office of the Chief of Naval Research for the development of Argo and Jason.

Ideally, Ballard would have liked to use the agile robot Jason, which earlier this spring had transmitted two weeks of live color video broadcasts from the floor of the Mediterranean to students around the United States and Canada as part of the Jason Project (box, page 34, and *Oceanus*, Vol. 32, No. 2, pp. 84–87). But without a three-mile fiber-optic cable, Jason could not be used on the *Bismarck* mission. Although not quite as maneuverable as Jason, Argo was still very well suited for the job. It could record top-quality black-and-white video images, and its still cameras could take high-resolution color photographs. Also, Argo could work at depth for days at a time (unlike manned submersibles such as *Alvin*).

On 11 July 1988, aboard the chartered British ship *Starella*, Ballard and his team first positioned themselves over the general area 600 miles west of Brest, France, where the *Bismarck* had met her fate. Argo was lowered into the water at the point reported by the battleship *Rodney*, one of the British ships

that had pursued the *Bismarck* until her final agony on 27 May 1941 (article, pp. 20–26).

The research team had only a general idea of the ocean floor in the area, so they carefully recorded the terrain as they searched. Below, the Porcupine Abyssal Plain stretched for miles in all directions. It was interrupted only by one small mountain range, roughly 1,800 feet high, called the Abyssal Hill Province. As Ballard says, "The last thing we wanted was for the *Bismarck* to have come down in here. And that's exactly what it did. We didn't know that at the time. When we began mounting the effort, we naturally picked the most benign terrain to begin the search."

Argo has two different sensing modes. Its sonar systems can cover a wide range of terrain. These are useful for spotting large objects, like the hull of a ship. Alternatively, its camera systems cover a reduced area, but can detect the smaller debris from a ship, which is usually more widely dispersed. Most of the search for the *Bismarck* was performed visually, because past experience points to more success by following debris trails. (The side-scan sonars, meanwhile, keep Argo from bumping into things.)

On 14 July, the crew picked up a debris trail that led to an impact crater "the size of a soccer field." Ballard and his team were convinced they had found the *Bismarck*. However, because of other commitments, they had to pull up their equipment and head for home on 21 July. Although they had not yet seen any distinctive features on video, they hoped unprocessed photographs would later give a definitive answer. And so they did, but not the answer the explorers were waiting for.

"The real sword in our heart in 1988 was the image of a teak rudder. We *knew* the *Bismarck* did not have a teak rudder," Ballard says. "We later discovered that right where the *Bismarck* was supposed to be was a commercial four-masted clipper ship from the 1800s. A fascinating subject unto itself, but not what we were after."

But 1988's search was not in vain. It taught the explorers about the conditions below. Since the clipper ship's debris trail lay north to south, they set up an east-west search grid in 1989. And since the clipper ship's trail had been strewn over 1¼ miles, they knew that a huge ship like the *Bismarck* would leave one as long or longer. To maximize their chances of finding it, they spaced their transects a mile apart.

The combined search area was increased from 20 square miles to a total of 120 (a search area 20 percent larger than for the *Titanic*). This area now included the mountain range. In 1989, Argo first went down on 29 May. Soon into the search, Argo picked up signs of light debris. The trail petered out to nothing. This pattern played itself out four times.

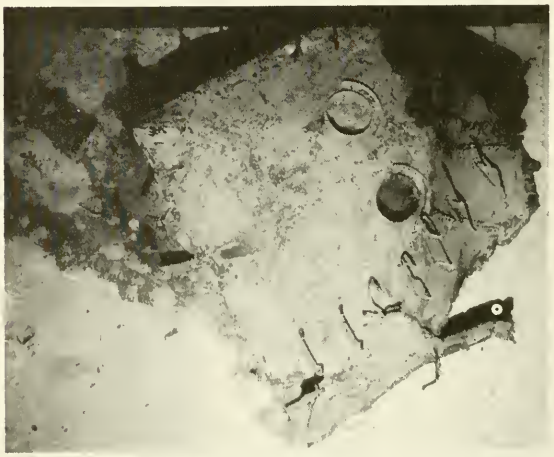
Then, four days before the expedition was scheduled to close, the researchers discovered yet another trail, finding increasingly larger

In 1988, the image of a teak rudder proved that the researchers had not yet found the Bismarck.

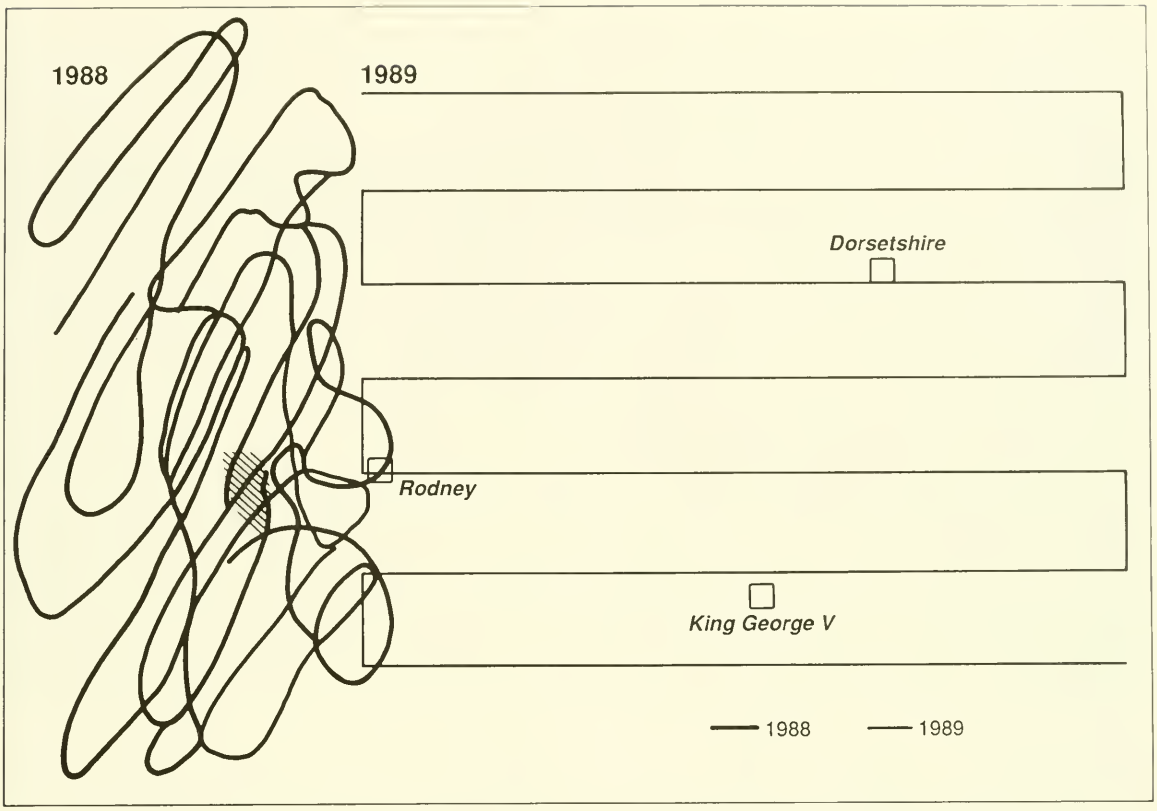
debris. Somewhat gun-shy, the team was not yet optimistic. Ballard worried that they might be looking at the remains of some other ship that had been torpedoed or lost during the war.

German WHOI graduate student Hagen Schempf—dubbed "the spirit of the cruise"—was very familiar with the *Bismarck* from historical drawings and photographs. He was the first to link this debris trail to the *Bismarck* when Argo came across a large piece of superstructure. The positioning of two small portholes and a ladder was distinctive, and the jagged outer edges of the metal indicated a violent explosion. The team was finally on the right track.

Soon the explorers could see that something had slid down the mountain range,



In 1989, the portholes and ladder on this superstructure debris were the first tell-tale signs that the Bismarck *lay nearby.*



Approximate ship tracks of the two-year search. British ships that fought against the Bismarck *reported three different sinking sites. The debris trail of a 19th-century sailing ship found in 1988 is shaded (left). The exact location of the* Bismarck *has not been disclosed by Ballard.*

causing a mile-long avalanche, but they could not tell whether it had been the ship itself or some other large structure, such as one of the four huge gun turrets that had fallen out of the ship. They circled the avalanche to see if there were any other impact craters nearby, but found none. After returning to the rut, they found a large object that they thought might be one end of the ship, but it turned out to be one of the turrets, lying upside down in the mud.

On the morning of 8 June, the sonar suddenly indicated a large object ahead. Kirk Gustafson, the "flier" controlling Argo at the time, was ordered immediately to raise the robot. "Five seconds later, there she was," Ballard recalls. "The ship's hull came into view, and then the guns. We knew we had found the *Bismarck*."

The gods of the seas, meanwhile, acted up. The calm weather that had blessed the explorers during the search phase suddenly turned around. "When we found the ship...the sea got very angry, very rough, very quickly," Ballard says. "For a short moment, we got up to 50-knot winds. The sea conditions were like when the *Bismarck* sank."

When Argo next hovered over the wreck, the researchers examined it thoroughly. Almost sixteen-thousand feet below, the *Bismarck* lies serenely, hauntingly, imperially upright, her superstructure blown away, her heavily armored hull rusting but essentially intact. Only the upper 30 feet of the wreck rests above the mud, which now appears almost as a waterline. This means it is not possible to assess damage sustained from torpedoes.

The fact that the *Bismarck*'s hull is intact, according to Ballard, confirms that scuttling played an important role in her sinking (box, page 30). "I have looked at scuttled ships. I have looked at ships that have fought scuttling—ships that didn't want to sink. Scuttled ships, because they open up their compartments, are fully flooded and fully pressure-compensated....

"There are no air passages or compartments like those in the stern section of the *Titanic*, which fought the sinking. If the *Bismarck* was buttoned up and held onto an air pocket, an implosion would go off catastrophically. You would certainly see some evidence of that, in the surface deck, or somewhere. When you see catastrophic implosions, as I have, you see that they are very explosive. We saw absolutely no evidence of any implosions."

From Argo's vantage point, the team recorded every square inch of the ship's upper surface on film. The mother ship for the 1989 expedition, *Star Hercules*, from Aberdeen, Scotland, was critical to such a complete survey.

Sunk or Scuttled?

After the Rodney arrived at Scapa Flow for refueling, after the Dorsetshire returned her German survivors to Newcastle, and after the Bismarck settled somewhere in the mud some 15,600 feet down, who can claim credit for sinking the Bismarck?

The Rodney, King George V, and the other British ships blasted the Bismarck with 2,876 shells, and not one penetrated her hull. Vice-Admiral Tovey, from his flagship, King George V, had radioed to Vice-Admiral Somerville: "Cannot get her to sink with guns." In all, the Prince of Wales fired the only two shells that exploded under the thick skin of the Bismarck, causing the oil slick and boiler damage during the Battle of Denmark Strait.

William H. Garzke, Jr., Staff Naval Architect with Gibbs & Cox, Arlington, Virginia, points out that the Bismarck was extraordinarily sturdy, and it was unlikely that all the shells that hit could have sunk her. The following is the total shells fired during the last battle.

Shell Type	*Number*	*Ship*
16-inch	380	Rodney
14-inch	339	King George V
8-inch	527	Norfolk
8-inch	254	Dorsetshire
6-inch	716	Rodney
5¼-inch	660	King George V

After several British ships were forced to retire because of dwindling fuel, the heavy cruiser Dorsetshire was ordered to torpedo the Bismarck until she sank. The cruiser launched two torpedoes at the port side of the battleship and a third at the starboard. Two were confirmed hits. Soon after, the mighty battleship went down. Even these last, seemingly crushing blows are insufficient evidence to give credit to the Dorsetshire.

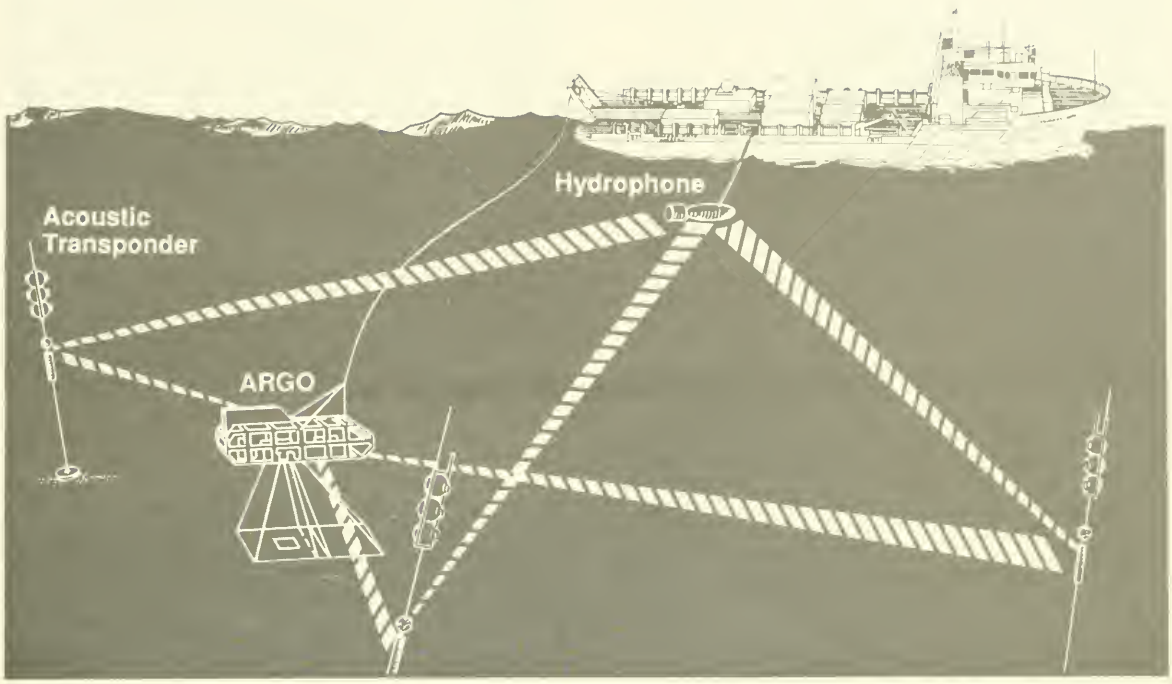
Scuttling, a procedure in which the crew floods the ship by reversing water pumps, opening seacocks, and exploding scuttling charges, was a routine in the German Navy, or Kriegsmarine, to assure that technology and material stayed out of Allied hands. The famous pocket battleship Graf Spee was ordered by Hitler himself to be scuttled to destroy its new technology. The aircraft carrier Graf Zeppelin, the pocket battleship Scharnhorst, and the heavy cruiser Admiral Hipper were all scuttled after their incapacitation by Allied forces.

German Vice-Admiral Stiegel (chief of German battleships) prepared a now-declassified, postwar report on the fate of Germany's last four battleships (printed in Oceanus courtesy of the Operational Archives Branch of the Naval Historical Center). Therein he stated that one of Bismarck's two surviving officers, Lieutenant Gerhard Junack, was issued orders to scuttle the ship. Stiegel included some of the Lieutenant's testimony: "Junack received orders to carry out 'Measure V.' This was an order which was to be executed after 10 minutes time if not previously countermanded, and specified the measures for scuttling a ship. For the execution of this measure, Junack and his party went above in order to open some valves on the middle deck; here he observed lights burning all over this deck, just as if the crew had gone ashore on a Sunday afternoon." Stiegel further noted that the ship capsized with her engines and electricity still on. If the ship had been sunk by the enemy, it is unlikely that these mechanisms would have still functioned.

The eyewitness account of the other surviving officer, former adjutant to Lindemann and fourth gunnery officer Baron Burkard von Müllenheim-Rechberg, further supports that the Bismarck was scuttled. "I certainly was aware, as I left the aft fire-control station at about 1020 [the time when the Dorsetshire launched its torpedoes], that the Bismarck was very, very slowly sinking. Heavily down by her stern, she was behaving as though one compartment after the other was flooding, gradually but irresistibly. She showed all the effects to be expected after the scuttling charges had been fired and the seacocks opened somewhere about 1000." So perhaps scuttling was responsible for Bismarck's sinking and the Germans can take the credit. But Garzke is quick to note that until the ship's underside, which is currently buried deep in mud, can be examined for metal rips bending outwards, we cannot be sure of the toll scuttling took, if any, in the Bismarck's demise.

At the press conference of 22 June 1989, Robert Ballard said the Bismarck appeared from the outside to have been scuttled rather than sunk. "Only scuttled ships tend to make it to the bottom in one piece." He also commented that it is "splitting hairs" to worry how the Bismarck went down: "Both of these things [torpedoing and scuttling] were going on at the same time."

Müllenheim-Rechberg feels the part of the torpedoes was small: "I am morally certain that the Bismarck would have sunk without these torpedo hits, only perhaps somewhat more slowly."



To search for the Bismarck, *the* Star Hercules *used an advanced method of navigation called dynamic positioning, which employs a computer linked directly to the ship's thrusters. Acoustic transponders on the bottom send distinctive sounds, and pick up sound from a hydrophone. To determine the ship's relative position, the computer monitors the time these "pings" take to travel to and from the ship. To move the vessel, scientists simply enter their desired position into the computer. It then makes calculations and sends instructions to the thrusters, constantly making adjustments whenever necessary.*

The ship—which Ballard fondly calls "a mud boat of the oil industry"—has advanced propulsion and dynamic positioning, an electronic method of controlling the ship and Argo. The researchers themselves can position the ship using a computer linked directly to the ship's thrusters. Before dynamic positioning, the researchers had to plot runs over a target and relay the data to the captain, who then had to try to keep the ship on course, fighting winds and currents. With dynamic positioning, the ship can follow search tracks very accurately, but more importantly, it can hover like a helicopter, or move a couple of feet at a time in any direction.

Ballard and his crew were amazed to find that *Bismarck*'s wooden deck appeared well-preserved, unlike *Titanic*'s pine deck. The German warship sits 3,000 feet deeper, but wood-eating microbes are equally active at both depths, according to Holger Jannasch, a deep-sea microbiologist at WHOI (profile, *Oceanus*, Vol. 27, No. 3, pp. 79–84). He says that the more resinous the type of wood, the more resistant it is to decomposition, because resin is toxic to deep-sea bacteria. However, resin is distributed unevenly in nature. If the deck is as intact as it appears, the microbiologist suggests it may have been treated throughout with a resinous preservative. Historical research should reveal whether this was the case.

The discoverers observed very few spots where shells had actually pierced the deck. This came as no surprise because of the close range at which the British were shooting; most of their fire traveled horizontally rather than in an arcing trajectory.

On one dive, the explorers lowered Argo into the space where one of the gun turrets used to be. This was an unusual move for the robot, which was designed only to be towed horizontally. "We turned Argo into Jason, Jr.,*" Ballard recalls. "I guess that was just out of frustration for not having Jason, but it was safe. These turrets are 28 feet across and we were dynamically holding, so what the heck!"

Periodically, the crew brought Argo to the surface to recharge its batteries and reload or check film. On one such occasion they remounted the regularly downward-looking cameras so they could look forward. Then Argo went down the side of the *Bismarck* and closed in on the armor plating.

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* Jason, Jr., the smaller prototype for Jason, was operated from *Alvin* on the second visit to the *Titanic* in 1986. It went right inside and made an eerie passage down the grand staircase.

Bismarck's Seaplanes

The starboard side of the hangar.

Some of the recognizable features on the Bismarck *wreck were the hangars where her seaplanes were stored, the catapult to launch them, and the cranes to recover them from the ocean. The* Bismarck *carried four, single-engine Arado-196 aircraft with twin floats. While two were stored beneath the mainmast, the other two were in ready-hangars on either side of the stack. The catapult was between the stack and the mainmast.*

None of the seaplanes were launched during the last nine days of the Bismarck *saga, but there were a few close calls. On 26 May 1941, a British Catalina spotted the* Bismarck *after her whereabouts had been unknown to British forces for more than 31 hours (box, pp. 14–15). The Germans fired on and considered sending their planes after it, but the seas were rough, and Captain Lindemann thought that recovery would be impossible.*

On 26 May, a Swordfish biplane landed a torpedo on the Bismarck's *rudder, destroying her ability to steer. Anticipating the worst, Fleet Commander Lütjens tried to send the* Bismarck's *War Diary to safety. One of the planes was put into the catapult, but a compressed-air line had broken, preventing the launch. Rather than leave the plane in the catapult, where it would be a fire hazard during battle, they drilled holes in the floats and tipped it off the side of the ship where it sank. What became of the remaining three planes is as yet unknown. The discovery team saw no sign of them during their exploration of the wreck.*

Inside gun turret Bruno.

The aft capstan.

The bridge was reinforced with thick armor.

"Rounds literally hit like bugs on a windshield," says Ballard. "We saw no penetration of the armor, but we did not inspect all of the ship since we were not able to go below the water line."

Once when the team was raising Argo, it suddenly became fouled in line. Their worst fear was that somehow the robot was attached irretrievably to the *Bismarck*. No one wanted to lose Argo, now valued at $300,000, nor the priceless data aboard. After painstakingly tugging the robot upward, Argo finally surfaced, along with hundreds of yards of entangled polypropylene—the origin of which is still a mystery.

The weather, meanwhile, remained rough—so much so that the researchers had to sit it out one day. After making their final photographic surveys of the wreck on 12 June, they raised their equipment for the last time. Almost on cue from the gods, the weather turned around again. The sea returned to a flat calm.

Next year Ballard will lead an expedition to the Great Lakes where Argo and Jason will probe ships lost during the Revolutionary War and the War of 1812. Since there are no deep freshwater animals that bore into wood, these ships should be in excellent condition. There's also very preliminary talk about looking for the huge Japanese battleship *Yamato* lost in 1945 off southern Japan.

Several nations were represented in the crew aboard the *Star Hercules*, including Britain, West Germany, the United States, and Canada. While steaming away from the wreck, they held a memorial service for those lost from both the *Bismarck* and her adversary, the *HMS Hood*. Everyone aboard, many in naval uniforms (Ballard himself is a Commander in the U.S. Navy Reserve), gathered on the fantail. British captain Derek Latter read the following commemoration, written by Schempf:

> *Being gathered here today gives us the opportunity to remember those British and German seamen who lost their lives during the days of this tragic sea battle.* We have the opportunity here to put to rest all those souls lost at sea during that battle. May they rest in peace from here on forth. We should look at this ceremony as a moment of remembrance for those people caught up in the turmoil of war, all of them having suffered; many of them dying. Let us hope that this kind of human sacrifice and suffering may never be asked of mankind again.*

A 30-second moment of silence followed. A makeshift wreath was thrown into the sea. □

A Cape Verdean sailor prepares a makeshift wreath to honor those lost from the Bismarck *and the* Hood. *(Photo by Joseph H. Bailey)*

A note to our readers: Ballard is writing his personal account of the quest for the *Bismarck*, to appear in the November 1989 edition of *National Geographic*. He is also the new host of the weekly television series, "National Geographic Explorer" on TBS SuperStation. This particular expedition will be recounted in a one-hour long episode entitled "Search for Battleship *Bismarck*," premiering on 29 October. We, the editors of *Oceanus*, thank the National Geographic Society for their cooperation in providing us with copyrighted visual material presented at Ballard's Washington press conference.

* Warships remain the property of their country, unlike commercial ships lost in the high seas, which are fair game for salvors and treasure hunters. In the past, the West German government has been adamant about leaving sunken ships in place as war memorials. According to Commander Jan Scharf, Assistant Naval Attaché of the West German Embassy in Washington, DC, East Germany has no claim to warships from World War II, since West Germany is the only successor of the Third Reich.

Your Kids and the Sport of Discovery

The discovery of the Bismarck *is linked to a crisis in American education. The searches for the German battleship in 1988 and 1989 were made on the final legs of cruises for the Jason Project, which aims to rectify this crisis.*

The United States is now ranked 17th in the world in scientific literacy. In U.S. colleges, 50 percent of graduate students in engineering, physics, chemistry, and math are foreign born. Many return home after completing their degrees, taking their newfound analytical skills and technical expertise with them. Robert D. Ballard, leader of the Jason Project, is certain these statistics do not result from problems during the college years, but rather much earlier. He observes that math is the favorite class of fourth graders, but by grade 12 it becomes the most dreaded. What is going on in between?

"Kids perceive science as something done by nerds sitting at computer terminals—sort of social misfits," Ballard says. "Kids are deeply affected by peer pressure in making decisions. They're saying 'I don't want to be a scientist' not because it isn't exciting, interesting, and stimulating, but because they don't want to be one of those people. They're turning off to science." Ballard's observations on childhood motivation come from close-hand experience, having two sons who have already passed through grade 12. His 20-year old son Todd accompanied him on both years of the search for the* Bismarck *and was flying Argo when they found the Roman wreck* Isis *during the Jason Project.*

The culmination of the Jason Project was the first live video broadcast from the bottom of the sea. According to Ballard, during the first two weeks of May 1989, enough kids viewed the Jason Project to fill the Superbowl three times over. Students gathered in museums and other educational institutions around North America to watch Ballard and his crew use the robot Jason for exploring underwater volcanoes and studying a graveyard of Roman shipwrecks. The aim of this project is to show America's youngsters that science is a healthy contact sport, played by a team.

Ballard and the major sponsors of the Jason Project (Electronic Data Systems, National Geographic, the Quest Group, Turner Broadcasting System, and the Woods Hole Oceanographic Institution) are planning to set up a Jason Foundation to continue relating the adventure of science and engineering to school children. The goal is to turn a whole new generation on to science.

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*Todd was killed in a car accident on 25 July 1989.

In May, thousands of school children gathered to watch live video broadcasts of Jason exploring the depths of the Mediterranean. (Photo by Tom Kleindinst, WHOI)

Ports & Harbors

Port Development in the

Boston Harbor
(©Photo by Spencer Grant)

U.S.: Status and Outlook

by John M. Pisani

The ports of the United States play a strategic role in the nation's trade, economy, and defense. Since its founding days, the United States has been dependent on water transportation for trade, and today every major metropolitan region of the United States centers around, or is closely linked by rail or highway with, a port. In addition to the coastal harbors and bays, port facilities have emerged along navigable inland rivers and the Great Lakes. The end result has been the creation of a vital network of ocean, Great Lakes, and inland river ports.

Functionally, deep-water and shallow-draft ports are the conduits for transferring cargo between water and land carriers. Their principal reason for being, however, is to further the economic development of surrounding communities by creating jobs, income, and tax revenues. Thus, U.S. ports mirror the economies of the regions they serve. They are sensitive to population and industrial growth, raw material patterns, and government policy.

Ports contribute significantly to the national economy as well. The U.S. Maritime Administration has determined that the total amount of economic activity generated by the U.S. port industry for the handling of waterborne cargo was $98 billion in 1988. This means that the total impact of U.S. ports on the economy averaged about $268 million a day last year. In addition, commercial port activities in 1988 generated 1.2 million jobs, a $50 billion contribution to the Gross National Product, personal income of $28 billion, federal taxes of $10 billion, and state and local taxes of $3.5 billion. Furthermore, approximately 70 percent of U.S. Customs revenues come from import duties collected at ports. This amounted to more than $13 billion last year.

Ports are no longer viewed as backwater institutions. The days are gone when ports were just docks. They are now seen as revenue

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John M. Pisani is Director of the Office of Port and Intermodal Development of the Maritime Administration, U.S. Department of Transportation, Washington, DC. *This article had been drawn from a paper prepared for the 16th World Ports Conference of the International Association of Ports and Harbors held in Miami Beach, Florida, in April of 1989.*

generators. Increasingly, ports are diversifying and becoming involved in nontraditional activities to enhance revenues. Boston and Baltimore are just two examples of several urban ports where waterfronts have experienced considerable mixed-use development and redevelopment in recent years with the construction of hotels, offices, condominiums, restaurants, and shopping malls.

Ports also are essential to our national security. U.S. commercial port facilities are used routinely for the shipment of military cargoes. Major naval installations are located at a number of U.S. ports. That number will increase with the construction of the new bases envisioned in the U.S. Navy's strategic home port initiative, which aims at spreading the fleet among several ports to reduce vulnerability from air or missile attack. Furthermore, two dozen ports have been designated as national defense ports to support the mobilization, deployment, and resupply of U.S. forces abroad during a major conflict.

The Present Port System

Port development in the United States has been the responsibility of both the public and private sectors. The U.S. government, through the Army Corps of Engineers, performs the dredging and maintenance of federally authorized navigation channels, and the construction of breakwaters, locks, and jetties. It also provides navigation aids such as lights, channel markers, and buoys. Public port entities and private industry at the local level plan, develop, and manage landside terminal facilities and services.

Bulk terminal facilities are usually built and operated by private companies, and public port authorities are the primary developers of transfer facilities for handling general cargo. The most common entity is the independent navigational district, administered as a public authority set up under state law to develop and manage a specific harbor area within defined political jurisdictions.

With no central port planning body, the United States has a system of diverse local port organizations. Although creatures of government, these state and local agencies engage vigorously in competitive commercial enterprise—their most visible activity. This public-private role allows port authorities to respond more quickly to their customers' needs, while at the same time attracting economic development.

Port and Waterway Channels

While the federal and local port roles have been performed successfully side by side for many decades, the Water Resources Development Act of 1986 (P.L. 99-662) made significant changes in the roles, obligations, and opportunities of U.S. ports. This act altered the roles of federal, state, and local authorities in accomplishing harbor and waterway channel improvements and maintenance. It required that local interests assume a greater responsibility and share of the costs of channel improvements and dredged material disposal.

The act further included the authorization of 48 new port and inland waterway projects at a total cost of $5.4 billion. A review of the progress made since the act's passage indicates that 23 navigation projects, both shallow- and deep-draft, are being processed by the U.S. Army Corps of Engineers, including 12 projects already under construction.

Historically, while Congress has delegated design, feasibility analysis, construction, and maintenance of these commercially navigable channels to the Corps of Engineers, it has appropriated the monies—with the exception of certain required local contributions and guarantees—from public revenues. This policy changed in 1978, when the 95th Congress approved P.L. 95-502, which requires user contribution to the construction of the inland waterway system by means of a fuel tax, now 10 cents a gallon. The Water Resources Development Act of 1986 will incrementally phase in an increase in the fuel tax to 20 cents a gallon between 1990 and 1995.

The public law that instituted the fuel tax, also established the Inland Waterway Trust Fund in the U.S. Treasury. Revenues from the tax are paid into the trust fund and may be used by the Corps of Engineers for up to 50 percent of the capital costs of a project only after congressional appropriation for the project.

In an effort to consider projects on a standardized biannual basis, Congress enacted the Water Resources Development Act of 1988. This act authorized three deep-draft harbor and three inland waterway navigation projects that would cost $827.8 million with a federal share of $418.8 million. An additional $387.5 million would be appropriated from the Inland Waterway Trust Fund to cover half of the construction cost of two locks and dams on the lower Ohio River.

Deep-Draft Port Facilities

There are 1,941 deep-draft marine terminals in the United States, with 3,214 berths for ships (Table 1). These figures include both publicly and privately owned facilities. The distribution of U.S. port terminals and berths among the four coasts is fairly even. The East Coast has the largest share of each, approximately 33 percent, with the Gulf and West Coasts accounting for about 25 percent each, and the Great Lakes totaling just under 20 percent. With respect to berth types, general cargo berths represent 38.4 percent of the total with no significant coastal concentrations. Dry bulk berths account for 22.5 percent with the heaviest concentrations in the Great Lakes (39.7 percent), Gulf (22.7 percent), and the North Atlantic (15.9 percent). Liquid bulk berths represent 19.9 percent with major concentrations in the North Atlantic (31.4 percent) and the Gulf (28.4 percent). Finally, passenger berths and other miscellaneous berths (barge, mooring, and

Table 1. U.S. port terminals by berth type and coastal range.

Berth Type	Berth Total	North Atlantic	South Atlantic	Gulf	South Pacific	North Pacific	Great Lakes
General Cargo Berths:	*1234*	*284*	*198*	*278*	*215*	*163*	96
General Cargo	666	165	84	207	85	71	54
Container	140	43	17	12	48	20	–
LASH/SEABEE	3	–	1	2	–	–	–
Roll on/Roll off (Ro-Ro)	34	7	18	2	3	4	–
Automobile	28	15	2	–	8	3	–
General/Container	39	16	6	1	7	8	1
General/Ro-Ro	44	8	10	14	10	2	–
General Cargo/Passenger	12	–	6	2	–	4	–
General/Dry Bulk	139	17	21	18	25	23	35
General/Liquid Bulk	83	2	25	15	16	19	6
Container/Ro-Ro	45	11	8	4	13	9	–
Container/Dry Bulk	1	–	–	1	–	–	–
Dry Bulk Berths:	*722*	*115*	*34*	*164*	*45*	*77*	*287*
Coal	58	16	–	11	2	–	29
Grain	95	10	1	30	10	9	35
Ore	66	11	3	6	–	6	40
Logs	15	–	–	–	–	15	–
Wood Chips	13	–	–	–	–	13	–
Cement	40	8	4	3	3	2	20
Chemical	78	8	4	49	3	6	8
Dry Bulk – Other	299	52	17	46	18	18	148
Dry Bulk/Liquid Bulk	58	10	5	19	9	8	7
Liquid Bulk Berths:	*640*	*201*	*53*	*182*	*85*	*67*	*52*
Crude	69	9	–	42	12	6	–
Refined	294	122	30	36	31	37	38
Petroleum-crude/refined	159	27	15	63	29	19	6
Liquified Petroleum Gas	6	1	–	4	1	–	–
Liquified Natural Gas	5	3	1	1	–	–	–
Liquid Bulk – Other	107	39	7	36	12	5	8
Passenger Berths:	*72*	*11*	*17*	*5*	*17*	*13*	*9*
Passenger	48	7	17	5	17	1	1
Ferry	24	4	–	–	–	12	8
Other Berths:	*546*	*198*	*18*	*131*	*52*	*76*	*71*
Barge	329	118	11	112	29	48	11
Mooring	101	35	6	11	7	18	24
Inactive	99	45	1	7	6	6	34
Other	17	–	–	1	10	4	2
TOTAL	3214	809	320	760	414	396	515

Includes those commercial cargo handling facilities with a minimum depth alongside of 25 feet for ocean ports and 18 feet for Great Lakes ports. Ro-Ro is short for roll on-roll off type cargo, such as trucks filled with goods.
Source: Maritime Administration, Office of Port and Intermodal Development, Port Facility Inventory

inactive) account for 2.2 percent and 17 percent, respectively.

The majority of marine terminals at U.S. seaports are owned by the private sector. They are predominantly dry and liquid bulk facilities. Public ownership, on the other hand, is heavily concentrated in general cargo and passenger facilities. Most of these publicly owned facilities are leased to and operated by privately owned terminal operators. Essentially, the operators of seaport facilities comprise 1) public entities or authorities, 2) independent marine terminal operators, 3) transport carrier-owned or related marine terminal operators, and 4) private industrial companies.

The deepest onshore terminal facilities in the United States for oil tankers are located at the Port of Valdez, Alaska, and include one floating pier having a depth of 150 feet alongside. The ports of Seattle and Tacoma in the state of Washington have the deepest draft capability for loading grain vessels, while Hampton Roads, Virginia, is the deepest coal export port, having recently loaded a collier destined for a South Korean steel plant with a record 151,000 tons of metallurgical coal.

Shallow-Draft Port Facilities

U.S. inland river ports and terminals are distinct from coastal seaports in several respects. Aside from being shallow (14 feet or less), these facilities are less concentrated geographically. The inland system combines both port complexes and isolated terminal operations alongside its river banks. Inland ports developed around metropolitan areas, as did ports of the coastal regions. However, unlike the coastal regions, the inland river system provides almost limitless access points.

Historically, this has permitted the selection of terminal sites to be determined by the needs and convenience of the private user, and today, 89 percent of inland facilities are

Table 2. Total U.S. domestic and foreign waterborne commerce from 1984 to 1987 (thousands of long tons).

	1984	Percent	1985	Percent	1986	Percent	1987	Percent
Foreign Trade	676.8	44	640.8	43	674.9	44	718.7	45
Domestic Ocean and Great Lakes	365.2	24	361.8	25	356.5	23	379.2	24
Domestic Inland and Intracoastal	484.3	32	477.3	32	500.4	33	508.7	31
Total	1,526.3	100	1,479.9	100	1,531.8	100	1,606.6	100

owned by private concerns. This compares with 64-percent private ownership at coastal ports. Bulk commodities represent about 89 percent of the business of these inland river terminals. The commodities are generally the products of, or raw materials for, the companies that built and operate the terminals. With so many terminals on shallow-draft rivers serving private users, handling capacity is adequate to meet the needs of commerce. At the remaining 11 percent of public terminals, the ability to handle needed commodities is sufficient because of a lack of congestion.

Since most river facilities are private terminals rather than public ports, the concept of a modern inland port authority is just beginning to emerge. Inland river ports and terminals are, on the whole, a composite of truck, rail, barge, and pipeline facilities. Thus they tend to be critical junctures in the national transportation network.

Comparative Commerce Movement

U.S. waterborne commerce illustrates the important cargo handling role of the nation's shallow- and deep-draft ports. The waterborne traffic at U.S. ocean, Great Lakes, and river ports consists of three types: foreign trade, domestic ocean and Great Lakes commerce, and domestic inland waterway movements.

Total domestic and foreign waterborne commerce handled at U.S. inland waterway, Great Lakes, and ocean ports ranged between 1.5 and 1.6 billion long tons annually during the 1984–1987 period (Table 2). During this four-year span, all three types of waterborne traffic remained relatively stable. Foreign commerce was the largest category of waterborne movements (the top 25 U.S. ports in 1987 handled 72.6 percent of the foreign trade by tonnage and 86.6 percent by value [Table 3]) but, when totaled, domestic ocean, Great Lakes, and inland waterway traffic comprised 55 percent of total movements. (In 1987, the volume of domestic ocean and Great Lakes cargo accounted for 24 percent of total U.S. waterborne trade.)

The inland and intracoastal waterways of the United States averaged 33 percent more tonnage than was moved in domestic ocean and Great Lakes commerce during the 1984–1987 period. The total transported in 1987 on the major waterways—the Mississippi River system and its tributaries, the intracoastal waterway systems of the Atlantic and Gulf, and the inland waterway systems of the north and south Pacific coasts—reached 508.7 million long tons. This compares with 379.2 million long tons for the domestic ocean and Great Lakes trades.

Table 3. U.S. oceanborne foreign trade for top 25 U.S. ports (1987).

Rank	U.S. Ports	Total Value (millions)
1	New York, NY	$47.4
2	Long Beach, CA	38.0
3	Los Angeles, CA	37.2
4	Seattle, WA	26.2
5	Houston, TX	19.5
6	Baltimore, MD	16.8
7	Tacoma, WA	14.9
8	Oakland, CA	13.8
9	Norfolk, VA	10.7
10	New Orleans, LA	10.7
11	Charleston, SC	10.2
12	Savannah, GA	7.7
13	Jacksonville, FL	6.9
14	Portland, OR	5.7
15	Philadelphia, PA	5.4
16	Miami, FL	5.4
17	Gramercy, LA	5.1
18	Boston, MA	3.9
19	Port Everglades, FL	3.4
20	Corpus Christi, TX	3.1
21	San Juan, PR	3.1
22	Wilmington, DE	2.8
23	San Francisco, CA	2.7
24	Baton Rouge, LA	2.6
25	Texas City, TX	2.4
	Top 25 Ports Total	$311.3
	All Other Ports	$ 48.2
	Total	$359.5

Source: Bureau of the Census, U.S. Department of Commerce.

Both dry and liquid commodities move on the inland waterways predominantly by barge, with dry cargo shipments exceeding the liquids on an approximate 60/40 ratio. The directions in which cargoes move depend on the product. Petroleum and fertilizers tend to move up the Mississippi River system from Gulf Coast processing facilities for agricultural and industrial users in the nation's heartland. Coal moves from the mining areas of Ohio, West Virginia, and Kentucky along the Ohio River for use in Midwest utility plants, as well as down the Mississippi to deep-water Gulf ports for export.

Port Financing

While absolute capital expenditures, improvements, and borrowing costs continue to rise, governmental subsidy and public support remain the same or decline. This inverse

relationship is pushing ports gradually to self-sufficiency. Ports must compensate for this widening income gap more from their own pockets and less from the outside.

Public ports can expect to be asked by all levels of government to assume a greater "pay as you go" policy, depending where possible on the reinvestment of port earnings and the most effective use of other short- and long-term financial resources. Ports can and do discuss pricing among themselves with antitrust immunity. But many ports are very reluctant to raise their usage charges to cover their costs and increase revenues because of fierce competition. In fact, some ports can generate profits through commercial waterfront development that can be plowed back into maritime cargo investments.

Today, many of the larger port authorities have the resources to issue tax-exempt revenue bonds, based on earnings and pledged assets of the port. This businesslike approach dates back to the mid-1970s and marks a clear shift from direct to indirect government assistance. Tax-exempt revenue bonds now represent about 60 percent of all financing for long-term capital improvement projects. Some ports have resorted to various other innovative financing methods, particularly short-term municipal market instruments, to offset rises in borrowing costs.

Environmental, Safety, and Security Issues

There are some major environmental, safety, and security problems that affect all U.S. shallow- and deep-draft ports. Erik Stromberg, President of the American Association of Port Authorities, at an international seminar sponsored by the International Maritime Organization, described five of the major environmental challenges facing commercial ports in the United States:

Public Involvement in Environmental Law: Today, it is within the power of the most modest local interest group, let alone national environmental organizations, to stop a port project. The legal focus is on the process, and by allowing full utilization of complex and lengthy regulatory procedures, development interests are faced with major cost increases extending over uncertain time periods, which may result in no project at all despite substantial costs sunk into the effort. It is in this legal context that port development projects in the United States must now be planned and implemented.

Dredged Material Disposal: The most prevalent single environmental issue facing ports in the United States is the proper disposal of dredged material, without which channel improvements would simply come to a halt. Ports are faced with a declining number of realistic disposal alternatives for the following reasons: upland sites are scarce; wetlands usually cannot be filled; acceptable mitigation opportunities are unavailable; there is a federal statutory presumption against open water disposal; where ocean disposal is the best alternative, sites are being designated farther out to sea; and state and local environmental agencies increasingly are advocating sediment testing and monitoring programs that could be more expensive than the dredging itself. The small volume of contaminated dredged material not only presents severe disposal problems, but the publicity, which this small fraction of the total volume of material generates, threatens the integrity of dredged material management strategies throughout the United States. The combined effect is quite serious for many ports as the cost of dredged material disposal becomes prohibitive, placing some port operations in jeopardy.

Contaminated Sediments: A second, and relatively new, environmental problem facing ports involves contaminated sediments, both in shoreside development, as well as in channel projects. Over the past decade, federal and state laws have been enacted that have drastically increased the liability of port agencies. Ironically, ports are confronted with the cleanup of budget-breaking liability exposure when they initiate property that was polluted either as a result of traditional operating practices that were considered harmless, or by acts of negligence by former landowners or tenants. Under the new laws, current landowners cannot easily escape liability.

Mitigation and Wetlands Preservation: Another serious nationwide challenge facing ports is the need to maintain and proceed with needed developments while at the same time meeting requirements to offset any resulting loss of critical wetlands. Today, ports must work within a system that prohibits filling even marginally valuable wetlands unless acceptable mitigation is undertaken. Unfortunately, land that could provide mitigation is nonexistent in most ports and harbors. As a result, ports are groping for local solutions without a coherent, long-range national policy, a situation which can lead only to needless delay and unnecessary expense in the search for acceptable mitigation.

Reducing and Relocating Urban Ports: With the gentrification of urban areas and higher real estate values (concerns, pp. 91–93), the pressure on ports to reduce the scope or relocate their operations is growing from local communities. These concerns are a by-product of operating in the urban environment where port practices can result in increased traffic near residential neighborhoods, a higher noise level, and lighted night operations.

Great Lakes and Inland River Ports

The Great Lakes and St. Lawrence Seaway penetrate deep into the industrial and agricultural heartland of Canada and the United States. The invisible border snakes for 2,000 miles between eight states and two Canadian provinces. The recent Free-Trade Agreement between the United States and Canada has reduced the barrier to cross-lake transport. Also, new ice-breaking ships in these waters have lengthened the navigable season to beyond nine months.

Alas, for all this system has going for it, its efficient use is scuttled by many factors.

Competition is intense. Ocean ports offer shippers faster, cheaper, and more frequently scheduled vessel service in overseas trade. These coastal harbors are easier to reach, dock, and leave. Railroads offer better prices for carrying international freight arriving at ocean ports, so shippers have given Great Lakes ports very little incentive to provide intermodal container cargo facilities. With an increasing share of the world's vessels unable to navigate the Seaway locks, the waterway remains—almost exclusively—a passageway for dry bulk traffic.

This trade is serviced by U.S.-flag vessels, including 1,000-foot self-unloading bulk carriers, and meets the large-volume shipping requirements of the U.S. steel, electrical power, and construction industries for coal, iron ore, gypsum, limestone, and cement ingredients. Canadian needs are similar. As the economic and demographic forces affecting these industries change, so will the shipping and port service demand on the Great Lakes.

Difficulties, even on these assured routes, continually throw themselves in the path of progress. Regardless of the Free-Trade Agreement, Canadian shippers are likely to continue their preference for Canadian vessels to those of the United States in the cross-lake trade. The logistics of Seaway navigation will always remain problematic. Tolls, pilotage fees, extra fuel consumption on long, winding voyages, and bridges and locks diminish efficiency and sustain a market for other modes of transport. The prosperity of Seaway commerce greatly depends on grain export by both nations, because there is little likelihood that overall general cargo tonnage will increase significantly. Great Lakes ports have kept their modernization apace with demand, but for the foreseeable future physical improvements will likely take place in bulk cargo facilities.

In addition to the St. Lawrence Seaway and the Great Lakes, inland ports and

Additional Pressing Concerns

Competition for waterfront real estate is becoming more intense in traditional urban port cities. Vacant or underutilized littoral maritime properties have become attractive investments for nonmaritime uses as the public and private interests seek access. The term "waterfront gentrification" is now a common term, describing the migration of urban populations to the waterfronts formerly devoted to commercial cargo operations. The maritime working waterfront must now share its space with commercial office buildings, retail centers, recreational facilities, and residential developments. This phenomenon has placed new pressures on the maritime industry and, in many cases, dislodged traditional activities, such as towboat and tugboat operations, barge fleeting areas, shipyards, and so on.

Safe and environmentally sound management of wastes generated by vessels and facilities in ports is another major problem. Marine terminal and ship operators at U.S. ports are concerned about the potential economic impact of waste-reception facility regulations for oil, chemicals, and garbage under the Act to Prevent Pollution from Ships. These regulations implement the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978, (MARPOL 73/78) in the United States. Their principal concern centers upon the potential hazardous waste liability issues related to the provisions of two important U.S. environmental laws, namely, the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

The control of air pollution caused by marine vessels will have significant impacts on U.S. port operations. Several states have included air quality standards for marine vessels in air pollution plans required by the Environmental Protection Agency. Additional states are expected to do so in the near future. The maritime industry favors federal preemption of state regulation of vessel air emissions in order to establish uniform nation-wide and

Are at a Difficult Crossroads

terminals are located along many navigable rivers. The major system remains the Mississippi River and its tributaries, including the Ohio, Illinois, and Missouri rivers. Most rivers are controlled by locks and dams to access waters for commercial and recreational navigation. Private barge and towing companies move large quantities of bulk cargo to and from public and private terminals. Increased rail competition and containerization have reduced general cargo freight at many inland river ports.

*The Seaway has little fear of running dry, but during drought, which may become more frequent in the future (*Oceanus *Vol. 32, No. 2), river shippers can suffer heavy losses. During the summer of 1988, the Mississippi River system receded to its lowest level in 30 years. The resulting disruption and higher costs caused some shippers to opt for railroad transportation. Inland barge transport is also very sensitive to the export trade in grain, and was hurt by the 1980 Soviet grain embargo.*

With few exceptions, the typical inland barge and towing company is in a survival mode—little capital and aging equipment. As a result, more companies may consolidate into fewer, larger companies. A similar situation has already occurred with railroads.

More than the forces of economy and nature, clouds of confusion blur the organization and planning of inland shallow-draft ports. A lack of port planning has precipitated large increases in costs of barge fleeting and cargo handling. Industrial companies buy waterfront land parcels and build their plants and docks haphazardly along river banks. The industrial park-type of developments that have been built by port authorities usually service other transport modes, and offer significant potential for intermodal movement on the nation's river systems.

There is a strong need for greater coordination between the inland waterway industry and the U.S. Army Corps of Engineers in scheduling lock repairs. Bad timing can put essential locks out of commission during the busiest part of the season. More military cargo travels on rivers now because it is cheaper; ports, however, are in danger of losing these customers. Thus inland waterways, although indispensable, are riddled with problems. Many of these problems can be mitigated and controlled with proper planning and communication. Attitudes and business practices must change with the times. But until such remedies are implemented, the full efficiency of inland waterway transport may not be realized.

—JMP

international standards.

During 1988, heavy fines were levied on some major U.S. and foreign shipping companies carrying illegal drugs on trade routes between U.S., South American, and Caribbean ports. This unprecedented action by U.S. Customs drew the attention of the U.S. maritime industry to the need for improved cargo inspection procedures at foreign ports. Shipping lines generally are hiring trained security guards and sniffer dogs, and installing x-ray machines and closed-circuit television equipment to detect potential drug smuggling. Two key issues between the maritime industry and federal authorities are 1) the responsibility industry is to assume in the nation's antidrug effort; and 2) the liability of shipping companies when drugs are found.

The vulnerability of U.S. ports to terrorist attacks is a constant concern of the U.S. Coast Guard. Using the International Maritime Organization's new preventive measures to protect passengers and crews, the Coast Guard has established maritime counter-terrorism contingency plans at a majority of U.S. ports.

Coastal Seaport Issues

Major shifts in world seaborne container movements have affected significant trade routes (article, pp. 47–50), and in turn, so has the directional balance of U.S. cargo flows with major impacts on land and water carriers, stevedores, terminal operators, and port authorities. To meet these changes, public and private entities are making decisions and investments in a deregulated marketplace, which will shape the future configuration of transport systems, both on water and on land, for the next decade.

U.S. deep-water public ports and private terminal operators continue to respond to the pressures of shipping and new transport technology with increased automation, berthing space, terminal equipment, and storage capacity. In particular, larger container vessels, load-center ports, and increased use of double-stack container rail services have spurred the growing volume of intermodal freight.

Container ships are becoming larger and more complex, and each ship imposes significant

demands on its ports of call. While some require a longer berth length, and a channel and berth depth of at least 45 feet, others require quay crane modifications in order to reach the farthest offshore containers on these vessels.

These container ships also effect immense problems on shoreside operating logistics. Backup storage space for large numbers of boxes as well as intermodal container transfer facilities, especially for rail, all have to be improved.

The load-center port—at which a carrier concentrates its operations by limiting port calls on a coastal range—has generated much concern within the industry. Indeed, the deployment of large container vessels is providing the driving force toward load centers. Despite their obvious economies of scale, these vessels are very expensive to operate. The largest are efficient enough that their high operating expenses can be controlled by fast port turnaround and high utilization. Therefore, the profitability level of these large container ships will determine the magnitude and pace of this evolution of port load centers in the future.

Physically modifying terminal facilities to fit the needs of double-stack train technology is critical for many ports. To remain competitive, these major load-center ports are marshaling the technical and financial resources necessary to achieve efficient interchange of containers between rail and ocean carriers.

The need to improve bridge and tunnel clearances on main and port-access lines is an issue that inhibits the growth of double-stack operations, particularly in the Northeast. Existing height, width, load limits, and curve radii restrict the use of double-stack equipment in this region.

Rail access impediments occur in most U.S. container seaports. When they do, they impose additional drayage costs, which add to the total delivered price of the goods, and thus reduce their competitiveness. On-dock rail transfer facilities for containers eliminate some of these costs and improve service. Of equal importance to rail-marine access at ports is moving trucks to and from marine terminals. Perhaps, in terms of volume and the unitary nature of trucks, it is more important. Direct access to major highways and interstate routes is also critical to those ports experiencing major increases in container traffic.

As the pace and volume of waterborne traffic have increased, so have reporting requirements, sometimes delaying shipment and creating port congestion and unnecessary storage charges. Thus the need for carriers, stevedores, terminal operators, and port authorities to automate and apply computer technology is significant, particularly in the management of cargo from origin to destination. Electronic information systems for rating and routing cargo, tracking shipments, stowing vessels, managing marine terminals, and releasing import freight are only a number of the technologies making up today's cargo automation mix.

Progress has been slower, however, in developing computerized control of container handling equipment used in U.S. marine terminals. The tendency has been to stay with manually operated equipment.

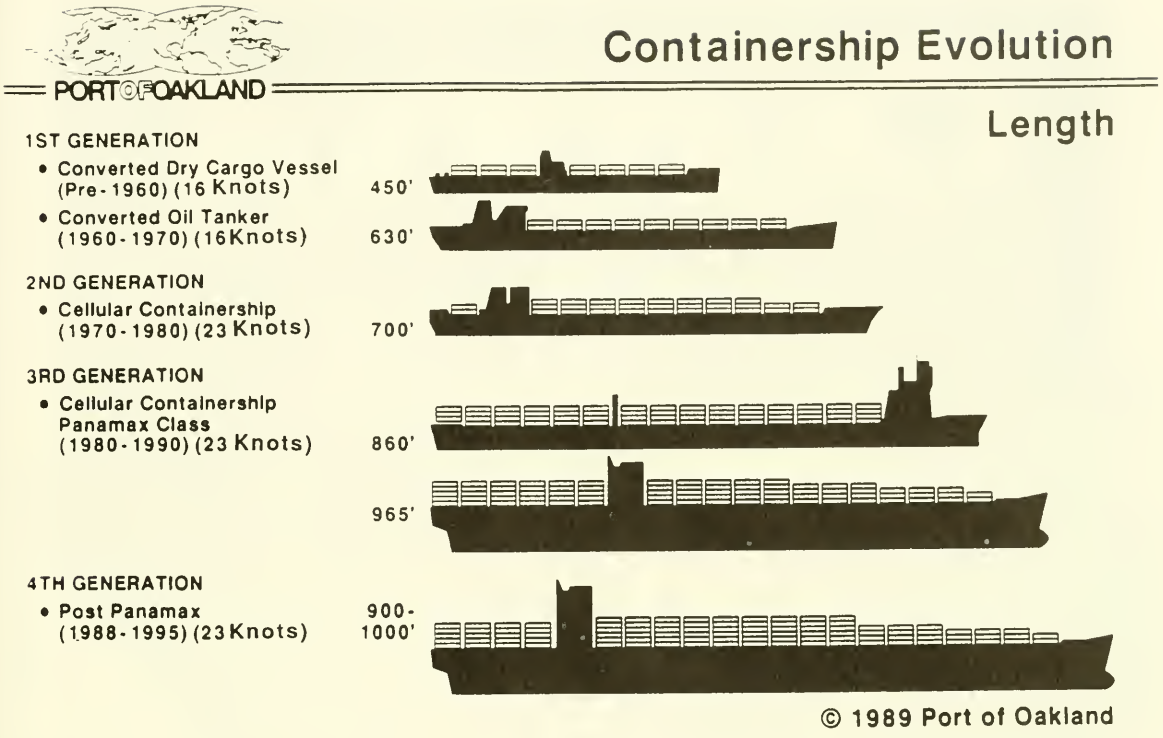
Marine container terminals worldwide are much alike in their capital-intensive development, despite drastically different labor costs. This is true because the entire system of containerized cargo transportation is extremely capital intensive and the essential elements of fast ship turnaround and high productivity are as vital in one port as they are in another. Labor costs now exceed 50 percent of the operating cost of major container terminals. At U.S. ports, longshoremen costs are significantly higher than at foreign container ports, particularly in Asia. Some skilled workers earn more than $100,000 a year (article, pp. 51–58), with the overall average of about $50,000 to $70,000. Acceptable productivity levels, therefore, can only be achieved with modern equipment and facilities, forcing capital-intensive developments in all areas, regardless of labor rates.

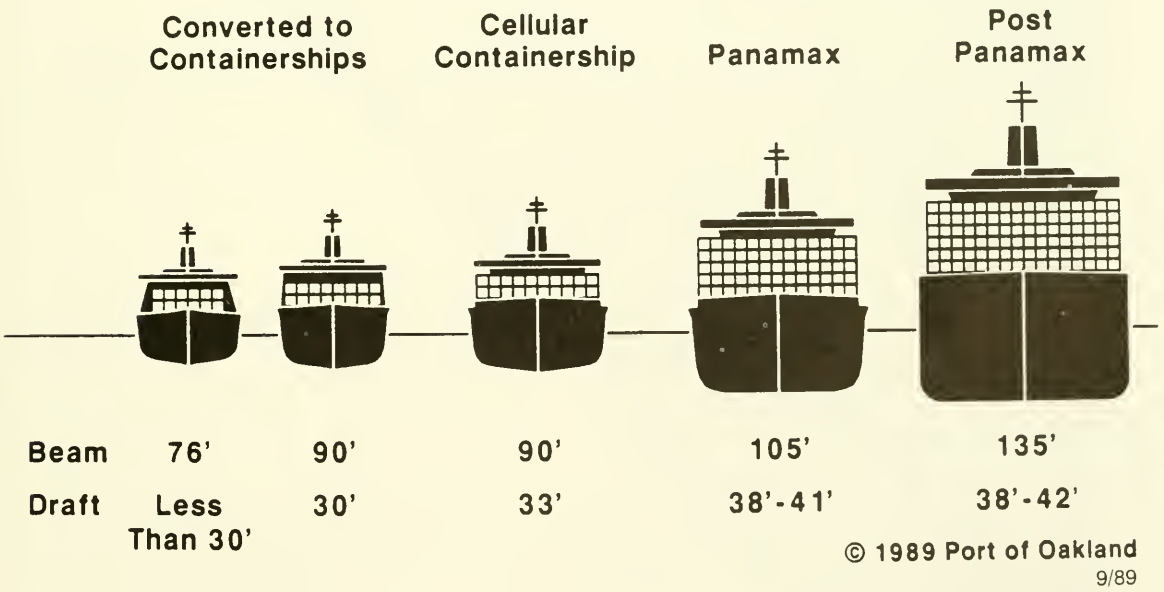
Outlook

What can public and private operators of marine terminals in the United States expect in the remaining years of the 20th century? Presently, these seaports are undergoing a period of prosperity. Revenues and traffic have increased from the depressed levels of the early 1980s. Public ports have experienced strong growth in international container freight and cruise passenger business. The end of the Persian Gulf War, improved U.S.-Soviet relations, and the U.S.-Canada Free-Trade Agreement should bolster the strength of the U.S. economy and trade, with concomitant benefits for its ports.

Improvements in vessel technology will continue to require modern port terminal facilities. The number of ships calling on U.S. ports is likely to decrease, but larger and more automated vessels will increase the amount of cargo handled per ship. The result will be greater cargo tonnages handled by seaports and the need for faster vessel turnaround. Expensive, high-capacity cargo-handling equipment will be increasingly used, and port terminal operations will become even more automated, particularly in container handling where robot-controlled equipment will come into use in the next decade.

Much of the stimulus for these developments will come from the steadily growing volume and changing nature of U.S. foreign trade itself, which is likely to exceed one billion tons in the early 1990s. The emergence of new trading powers during the next decade will partially account for this expanded cargo volume at the nation's seaports. Therefore, increased demand will be exerted on vessel and port terminal operators to become more productive, and hold down the costs of shipping this additional cargo. This translates into a steady pressure for new technology to increase the





speed and efficiency with which these cargoes can be moved.

The ability of U.S. seaports to proceed in a timely way with development projects in a climate of heightened public involvement and regulatory restrictions will be difficult, expensive, and complex. In the coming years, the environmental challenge will only intensify as port facility expansion and dredging needs come up against the proliferation of federal, state, and local laws.

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The Port Director's Dilemma

Many Storms in a Port

by John Ricklefs

Commercial ports are competitive entities. Competition is the driving force behind a port director's considerations; and in the United States, ports compete with each other to serve the same shipping lines. I recall the recent experience of a shipping line whose contract for service with a port on the South Atlantic was about up for renewal. The line received proposals from 12 other ports, many of which were located on totally different coastal reaches.

Port competition is then not a simple function of geography, as innovations in transportation technology have changed the boundaries of traditional hinterlands. Boston's Massport, for example, struggles not only with its neighbors to the north and south—Halifax and New York—but also with ports on the Pacific west coast and the South Atlantic. In many critical ways, this competitive struggle is not simply to maximize market share, but often to avoid going out of business. Just as in the private sector, the market is never big enough to go around.

The second thing to keep in mind about the port director's world is that in the port business it is always a buyer's market because of the overabundance of port facilities.

Thus, knowledge of the market is fundamental; and in the container intermodal industry, the market is first, last, and always an international phenomenon. No cargo will flow across the berth that is not carried there by one of a relatively small set of international shipping companies. Each of these companies has its distinct corporate culture, serves shippers and consignees worldwide, calls on ports around the world, and operates in the United States with antitrust immunity. To gain their business is, for the port director, to stay in business. The shipping line is the customer.

The Shifting Trade-Route Factor

Traditionally, there were two key international factors that drove shipping lines to choose a string of ports that would form a trade-route loop. The first of these factors was the foreign origin or destination of cargoes carried on the loop. We can attribute much of the competitive disadvantage experienced particularly by North Atlantic and Gulf Ports to the historic shift of a major share of the world's cargoes to Asia. In 1978, for the first time the tonnage of cargo traded between the United States and Asia eclipsed that traded with Europe.

Hong Kong's towering skyline is an anachronistic backdrop for this traditional Chinese junk.

Trade parallels investment, and investment is forever searching the globe for higher productivity. I provide management advice to many ports in Asia. One of my favorite ports is Pinang, on the Strait of Malacca in Malaysia. Pinang is also a favorite of tourists visiting Southeast Asia. It is known as the city of a thousand Buddhas.

I have spent many wonderful hours wandering along the tiny streets of Pinang, examining the wares in small market stalls and marvelling at the classical Chinese opera house and square. The city has always seemed to me to be antique, serene, and a bit sleepy—that is until it was discovered by global investment capital.

Only a year ago, Pinang became a star in the electronics market. Recently, I visited a new electronics plant, built in about four months and employing about 1,000 people. The machines

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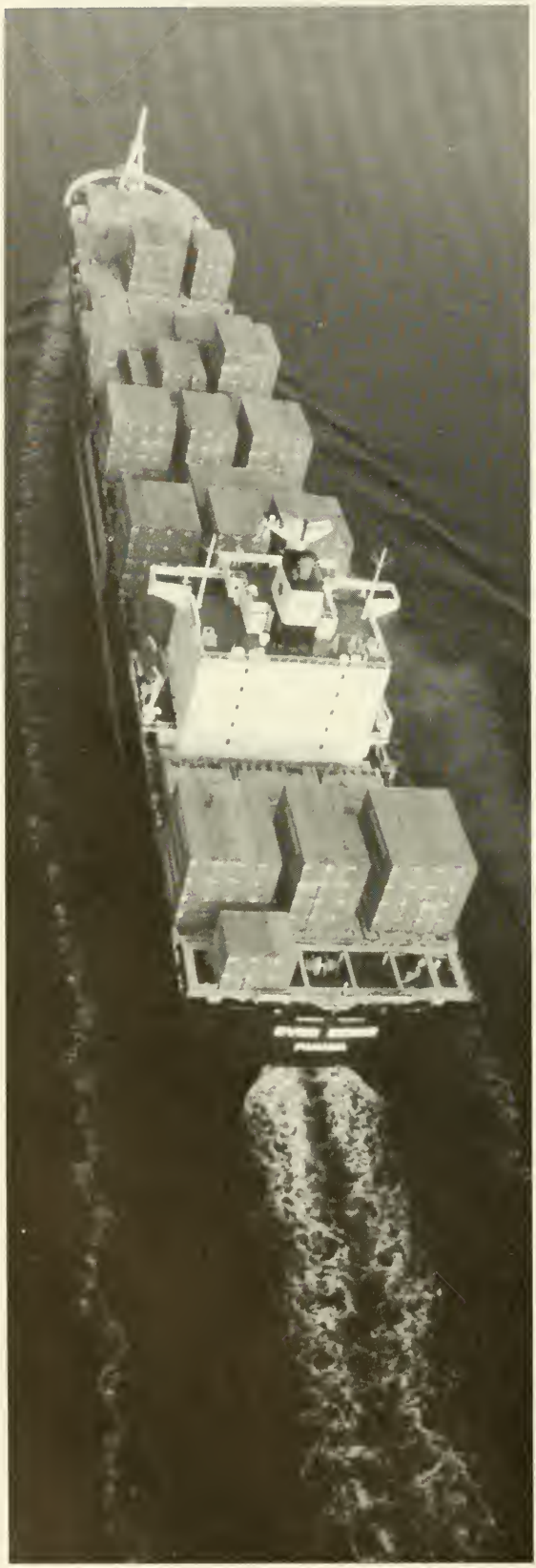

used by the workers were still on skids. I was told they would not be taken off, because the plant might have to move quickly to a more profitable location.

Most of the output of the plant, and that of Southeast Asia in general, is destined for the United States. Typically, it is picked up at local ports such as Pinang, transshipped to larger carriers at Singapore, and often transshipped once more at Kaohsiung or Hong Kong before it is carried (at least 70 percent of it) to ports on the west coast of the United States. Once in the United States, the cargo is placed on double-stack rail cars and moved to cities in the Midwest or on the East Coast.

But things change; and thanks to those skids, things are changing faster than ever. As investment in more-productive facilities moves from East Asia to Southeast Asia, and spills over into the Indian subcontinent, new trade routes form. Before long, cargo from Asia—together with European-destined goods—will travel via the Suez Canal and the Mediterranean, and be unloaded at U.S. east coast ports.

If an east coast port director is on his toes, he is aware of these changes and is preparing now to offer the right steamship line the facilities it needs. Savvy west coast port directors are preparing to fight this tendency by offering new incentives designed to improve the competitive position of all-Pacific carriers.

The Balance Factor

The second factor that drives a shipping line to choose a specific port is the characteristics of the cargo that can be collected at the ports forming a possible trade route. These characteristics include the volume, value, and most importantly, the balance of loadings and unloadings. Everything remaining equal, a shipping line's profit is most affected by this balance. This means that the transportation equipment deployed over the trade route must be utilized to the maximum extent at all points on the route.

The shipping line deploys its ships—known in the trade as "capacity"— over a trade route, which consists of nautical miles and ports of call. Each ship has technologically determined cost characteristics. The most important characteristic is the ship's size. The experience of the United States Lines proved, despite the line's demise, that bigger ships can possess significant economies of scale. In fact, in eight short years, the average size of mainline vessels has more than doubled. Recent orders are nearly all for ships able to carry more than 3,000 Twenty-foot Equivalent Units (TEU*). As ship size goes up, the cost per TEU-mile goes down, assuming that threshold load factors (capacity utilization) can be maintained.

* A 20-foot Equivalent Unit is a unit of volume about 9 feet high by 8 feet wide by 20 feet long. It is a standard unit in the container-ship industry, although containers themselves can be 20, 40, and 45 feet long.

(Photo by Terrence McArdle, Port of Baltimore)

This is where balance comes in. Each port of call must not only be able to supply sufficient volume to maintain the load factor, but do so in terms of both loadings and unloadings. To do this, containers must arrive at the port from an extensive market area, or hinterland. As ship size grows, it takes an increasingly larger hinterland to supply on a regular, seven-day basis the large and balanced flow of containers required to maintain the level of load factor needed to qualify for profitable service. Achieving this results in a phenomenon called load centering.

Load centering has been with us for years and will continue at an ever-faster pace in the future—big ports will get bigger, faster. Smaller ports will increasingly convert to "feeder" status, or fall by the wayside.

A New Factor—Domestic Containerization

The origin of cargo and its balance over given trade routes—in the context of deployed vessel capacity—no longer represent the only factors that determine a shipping line's selection of its ports of call. A third factor is the growing use of containers for the carriage of domestic cargoes.

The use of what is called "minibridge" rail service to move containers from west coast ports to the Midwest and East Coast, was an early attempt to confront the problem of cargo imbalance by attempting to load containers (that would have otherwise returned empty) with domestic cargo. But it was the innovation of the doublestack rail car that thrust this service into real competition with intercity motor carriers for domestic cargo.

An examination of the financial returns of those lines that are active in providing domestic container service shows this business is a growing and important source of revenue. In all probability, as domestic cargoes grow, international cargoes will become increasingly marginal to container carriers. Increasingly, the pricing of international service will be a function of domestic factors. Thus, lines active in domestic service will manipulate their international service to provide high-value and balanced cargoes for their inland trade routes.

In the future, one of the prime factors in the selection of a port of call will be the correspondence of inland route service to high-density movements of intercity domestic containers. The wise port director is thus only too aware that his historic disdain for domestic freight may lead to his port's loss of international freight.

Port directors must struggle with these forces if they are to protect their investment. They must compete. The basic response of any economic entity facing competition is to increase productivity. Ports can theoretically increase productivity by increasing operating efficiency and labor productivity, or by providing new facilities with improved technologies.

There are approximately 80 seaports in the United States. A little more than half are landlord authorities—that is, they own but do not operate facilities. With few exceptions, the larger, load-center ports are landlord ports. A landlord port by definition does not have the ability to deal in any significant manner with either operational or labor productivity, because they neither operate nor control the labor at the berth. Thus, when faced with growing competition, the only direct outlet available to the landlord port is to invest.

A Promise of Future Conflict

In the future, I believe that we will see more innovation in the organization of U.S. ports, particularly as regards operations. The potential of productivity improvement derived from changes in operations and in the utilization of labor, far outweigh those that could be derived from those facility-related technological changes on the horizon.

Under present circumstances, however, most port directors are limited to one reaction in the competitive struggle—that is, to invest in bigger, deeper, and more sophisticated facilities. Inasmuch as facility development is so closely linked to competition, one can understand the port director's interest in being able to build, as fast as possible, that which is most advanced without regard to the actual increase in total available demand.

We can expect to be faced with projects for extending and deepening berths and the addition of new, more advanced equipment. Even more significant will be the port's need for additional land. Beyond the addition of new terminals will be the demand for land to be used for on-dock rail yards and trade-related industrial parks. In ports where land for expansion is not available, we will see new projects for dredging and filling the harbor to create new land. Ports also will become increasingly involved in the improvement of highway and railway access to the hinterland.

So the scene is set for conflict between the port and other users of our harbors. In my view, the achievement of consensus in this regard will be severely tested by the unyielding circumstances in which today's port director must function. □


The Longshoreman
From Wharf Rat to Lord of the Docks
by Mark Lincoln Chadwin
I'm called dock-walloper and wharf rat
With many laughs and many knocks.
In spite of that, I glory in my element
I'm one of the Lords of the Docks.
—from The Longshoremen

Three men share the same line of work. One is an accomplished yachtsman, who has raced his 38-foot sailboat to several regional championships. Another likes to spend his evenings relaxing on the patio of his half-million dollar home overlooking the Atlantic. The third, a college graduate with a Phi Beta Kappa key, is a former captain in the U.S. Navy.

Three engineers? Attorneys? Doctors? No. All three are longshoremen. Although they may not be typical, they are probably more representative of their fellow workers than the popular stereotype of longshoremen—illiterate, heavy-drinking, and combative men who earn an erratic living muscling crates, barrels, and bags of cargo to and from the holds of ships.

The Origins of Stevedoring

For the first three centuries of stevedoring in the United States, that stereotype was not far from reality. According to maritime historians, dock work began in this country as an occasional, part-time form of work. In pre-Revolutionary War times, when an incoming vessel was sighted, a bell would be rung, a flag raised, or bonfire lit. That would signal the need for "men along the shore" to load and unload cargo. Men whose basic livelihood was made in other ways would respond in hopes of earning a few coppers.

Gradually, the work of the "alongshore men" became more specialized and more organized, especially in the major seaports of the new republic—Boston, New York, and Philadelphia—where cargo vessel arrivals were a frequent occurrence. Groups of men (called "gangs") coalesced and became identifiable—perhaps for their cleverness in stowing cargo securely in a ship's hold, or for their reliability and endurance. From within the gang, one or two individuals emerged as leaders or "bosses." They usually were men who were particularly clever at cargo handling, especially adept in bargaining with ship owners, or physically the toughest.

Since there generally was intense competition for dock work, these "bosses" and their gangs understood that it was crucial for them to have one location where a ship's agent could find them quickly. Very often the place chosen was a tavern or inn close by the waterfront. Frequently, too, the bartender would serve as hiring agent and paymaster.

When word came that a vessel was arriving, there would be a desperate scramble, especially when work was scarce. Whoever was first to the dock would often get the work. However, rival gangs could be played off against each other by the shipowners, and fights would sometimes break out between gangs or even between members of the same gang. With a continuous flow of immigrants arriving in the seaports, there usually were more men than there was work, and the owners, agents, and captains had the whip hand.

The life itself (like stevedoring until recent times) was a matter of "hurry-up and wait." It might begin with days of restless uncertainty, as the members of the gang loitered at their chosen tavern or elsewhere, awaiting word of the next vessel's arrival. Then there might be a rush to their gathering place or to the dock in an effort to secure a job for the day. For those fortunate enough to be selected, more hours of waiting ensued before the vessel actually docked and unloading could begin. Then came a period of intense physical effort. It might last only an hour for some before they were laid off, or it might extend all day and night and part of the next day. Since the ship's captain or owner wanted the vessel "worked" and back to sea as fast as possible, only meal breaks would be permitted. When the vessel was done, the gang might wait days or even weeks for another job.

The immigrants who began arriving in the seaports in the 1840s were different from their predecessors. They were predominantly Irish and Roman Catholic. Uneducated, impoverished, and the target of attacks by "Know-Nothings" and others, the Irish immigrants were viewed with suspicion and discriminated against. They sought to survive on what work they could find. For the men, the choice was either endless hours of dreary routine in a factory, or some form of outdoor, but irregular, physical labor, such as stevedoring. By the end of the Civil War, 95 percent of the stevedores in the ports of the Northeast were sons of Ireland and their progeny.

The image of longshoremen that developed was, thus, an unattractive one—of brutish, alien, hot-tempered men, who were unable or unwilling to hold a steady job and who spent much of their time drinking and loitering in waterfront saloons. About the only time their activities came to the attention of newspaper readers and public officials was when a strike was called, and then, too, the publicity was largely unfavorable.

A Century of Setbacks

For dockworkers, the 19th century was a chronicle of efforts to organize and to improve wages and working conditions—all of which ended in failure. The first recorded dock strike (for an increase in hourly wages) occurred in 1836 in New York City. It spread to Philadelphia, but was quickly suppressed by the use of strikebreakers, who were protected by armed militia.

The last third of the century has been characterized as the "Robber Baron" era. The prevailing public philosophy was Social Darwinism—survival of the fittest, with little concern for the human costs. It was a time of mass immigration, enormous exploitation in the workplace, and bloody labor strife.

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On the docks, as elsewhere, workers responded to low wages, long hours, and dangerous working conditions by unionizing. Although each of the northeastern ports spawned several waterfronts unions, the Longshoremen's Union Protective Association of New York (LUPA) was probably the largest. LUPA, like the ethnic and neighborhood benevolent and protective societies which were proliferating, had among its aims the welfare of the families of its members and "the burial of the dead of our society." LUPA's stated purposes also included "regulating and protecting our interests, wages, and the manner and time of employment . . ."

The effort soon suffered a major setback. In the aftermath of the Crédit Mobilier scandal* and the bank closures that occurred during the panic of 1873, the economy staggered and waterborne commerce slowed. Shipowners, confronted with declining cargoes and falling freight rates, announced in New York that the pay for day work would be reduced from 40 cents an hour to 30 cents and that the rate for night work (which was more dangerous) would fall from 80 to 40 cents. "Those not agreeable to working at the stated rate," their announcement added, "need not apply at the piers."

A strike ensued. Initially civil, it degenerated into a series of riots and clashes among the strikers, strikebreakers (or "scabs"), and police. The dockworkers received no support from other unions, many of whose members crossed the picket lines to deliver and pick up cargo at the docks. The shippers, correctly assessing the dockworkers' economic and organizational weakness, refused all requests to negotiate. After a month, most of the strikers, their meager savings exhausted, accepted the lower pay scales and reapplied for work. Many strikers were blacklisted, wages were pushed down even further, and longshoremen's unions were moribund for a decade.

The docks remained relatively quiet until the Depression of 1884. By this time, the Knights of Labor, intent on uniting all American wage earners into a single labor movement, had developed into a national organization with nearly a quarter of a million members. In 1884, they moved to organize dockworkers in the east coast ports.

The Knights of Labor made remarkable gains in membership and strength along the docks until the "Big Strike" of 1887. As in 1874, the strike was precipitated by wage cutbacks, this time by the Old Dominion Steamship Line (which ran coastal vessels between Newport News, Virginia, and New York City) and by coal handlers in ports along the New Jersey shore. The strike spread until nearly all cargo movement in the ports of New York and New Jersey had stopped.

Furthermore, the support of longshoremen in Newport News was secured. This was important because it deterred a traditional management tactic—playing off the dock workers of one port against another. This maneuver often involved diverting vessels headed for a northern port that was being struck to a southern port. There the cargo would be unloaded by lower paid, predominantly black stevedores and sent north by railroad.

The companies responded to the 1887 strike by instituting lawsuits against the union, hiring Pinkerton guards and nonunion workers, and spreading rumors that the union intended to secure pay for southern black stevedores equal to that of white dockworkers in the North. A Knights of Labor leader was arrested and jailed for conspiring to damage Old Dominion Steamship Line property.

As in 1874, lack of solidarity and tactical misjudgments led to the union's defeat. Strikebreakers protected by Pinkerton guards were used to bring coal from the New Jersey ports to the factories and power plants of Manhattan. The small union whose men ran the steam plants rejected pleas to support the strike by not burning the "scab" coal. The Knights, desperate for a settlement, reached an agreement with the coal handlers. Then, they declared the portwide strike a victory and called for a return to work. Demoralized and disillusioned with the union, the dockworkers came back to the piers in droves, accepting whatever terms the employers offered.

The Rise of the ILA

The longshoremen's organizations of today originated at the turn of the century. Curiously, their roots were not in the ports of the East Coast but in those of the Great Lakes, especially Chicago. There, Dan Keefe, a former tugboat crewman, founded what would become the ILA, the International Longshoremen's Association.

Unlike many of his predecessors, Keefe was a realist, a pragmatist, and a diplomat, even with his adversaries. According to one biographer, he "shrewdly assessed the power of his opponents—and good tugboat man that he was—charted a course of caution." By 1905, his union claimed more than 100,000 members, mostly in the Great Lakes, but also with locals in Canada, Galveston, Hampton Roads, and Baltimore. Shortly afterwards, the ILA was accepted into the American Federation of Labor (AFL).

During the next decade, the ILA captured the ports of the Northeast as well, sometimes after a struggle. In New York, remnants of the old LUPA structure lingered on. Predominantly Irish in makeup, LUPA sought to keep Italians and other immigrants from southern and eastern Europe off the docks, preserving the work for themselves. As the ILA absorbed or overran the

*The famous scandal involved influential stockholders of Pacific Union Railroads who created the Crédit Mobilier Construction Company, made contracts with themselves, reaped millions in profits, and depleted large congressional grants to Union Pacific, sending it into heavy debt.

LUPA units, the new union reached out to recruit these new Americans as well.

Another competitor the ILA faced was the International Workers of the World—the IWW or "Wobblies." However, the IWW's atheistic and anarchistic tendencies did not engender widespread support among the predominantly Roman Catholic longshoremen of the Northeast. Furthermore, once the United States entered World War I, the Wobblies' militant pacifism outraged the patriotic dockworkers. Shrewdly playing on the rise in nationalistic fervor that accompanied the war, one ILA leader declared, "ILA means I Love America." Over the years, that slogan would be repeated again and again in ILA speeches.

The war itself had an enormous impact on the docks. As many dockers departed for the service, the amount of stevedoring work to be done soared. This imposed an enormous workload on those who remained. However, it also made their services critically important to the war effort. That allowed the ILA to win wage increases and other concessions, such as a minimum two-hour shift.

Prohibition, Depression, and War

Always a rough place and sometimes a violent one, in the 1920s, the docks began to develop a reputation for hardened criminality. Some historians attribute this to Prohibition and the liquor smuggling that accompanied it. Cargo piers were, of course, a logical place for such illicit commerce, and gangster elements began to infiltrate the waterfront. As time went on, some ILA locals, especially in New York, fell under gangster control, and kickbacks, payoffs, loansharking, "sweetheart" contracts, and strong-arm tactics became widespread. An unsavory image was developing that would plague the shipping industry until at least the 1970s.

The Crash of 1929 and the Great Depression that followed threatened to tip the balance of economic power between dockworkers and management in favor of management again. As international trade dwindled and demand for dock labor declined, the longshoremen and their union seemed about to lose all that they had gradually gained during the prior 30 years.

However, the advent of the New Deal and the labor laws of the Roosevelt administration shielded the dockworkers and the ILA from a recurrence of earlier setbacks. ILA membership tripled in South Atlantic and Gulf Coast ports. On the Pacific Coast, where company-controlled unions had long held sway, the ILA won election as the longshoremen's bargaining agent.

ILA presence on the West Coast was short-lived, however. A faction under the leadership of Australian Harry Bridges, a Communist sympathizer at the time, took control of the ILA in San Francisco. During a strike in 1934, Bridges initiated a struggle with the national ILA and its president, Joseph Ryan. The conflict was partly about ideology and partly about strategy. (Bridges favored maritime industrywide action in

ILA members picketing in San Francisco, 1934. (Courtesy of Bancroft Library, Berkeley, CA)

Strikers battle police in San Francisco; July 1934. (Courtesy of San Francisco Public Library)

(Bancroft Library, Berkeley, CA)

Bloody Thursday

In 1934, maritime workers waged one of the great battles in the history of the American working class. The 83-day "Big Strike" transformed labor relations in the Pacific coast maritime industry and ushered in an era of militant unionism.

On 5 July, the San Francisco waterfront became a vast tangle of fighting men as several hundred police tried to move scab cargo through picket lines in what became known as Bloody Thursday. Following is the eyewitness account of Donald M. Brown:

> Struggling knots of longshoremen, closely pressed by officers mounted and on foot, swarmed everywhere. The air was filled with blinding gas. The howl of the sirens. The low boom of the gas guns. The crack of pistol-fire. The whine of the bullets. The shouts and curses of sweating men. Everywhere was a rhythmical waving of arms—like trees in the wind—swinging clubs, swinging fists, hurling rocks, hurling bombs. As the police moved from one group to the next, men lay bloody, unconscious, or in convulsions—in the gutters, on the sidewalks, in the streets. Around on Madison Street, a plainclothes man dismounted from a radio car, waved his shotgun nervously at the shouting pickets who scattered. I saw nothing thrown at him. Suddenly he fired up and down the street and two men fell in a pool of gore—one evidently dead, the other, half attempting to rise, but weakening fast. A gas bomb struck another standing on the curb—struck the side of his head, leaving him in blinded agony. The night sticks were the worst. The long hardwood clubs lay onto skulls with sickening force, again and again and again till a face was hardly recognizable.
>
> *At the end of the day, two workers, one a longshoreman and the other a strike sympathizer, lay dead.*
>
> —*From* Workers on the Waterfront, *1988.*

collaboration with the seafaring unions.) It also was a clash of two determined men who were rivals for organizational power. In the end, the west coast unions under Bridges split off to form the International Longshoremen's and Warehousemen's Union (ILWU), which continues to represent Pacific coast dockworkers today.

World War II, like its predecessor, reinforced both the legitimacy and the leverage of the dockworkers and their unions. Thus, they entered the postwar era at a pinnacle of power, self-confidence, and respectability.

Corruption on the Docks

In the early 1950s, however, that respectability was badly compromised when a series of investigations in the Port of New York-New Jersey generated months of public hearings and

FYI: It's Abe, Not Moscow

In the face of a particularly virulent attack on the maritime unions by publisher Henry Sanborn and his right-wing weekly, the American Citizen, *the publicity committee of the San Francisco International Longshoremen's Association local countered on 13 February 1936, with a lengthy statement outlining "the kind of Americanism which the Maritime Unions subscribe to":*

> Labor is prior to and independent of capital . . . Inasmuch as most good things have been produced by labor it follows that all such things belong of right to those whose labor has produced them. But it has so happened, in all ages of the world, that some have labored and others have, without labor, enjoyed a large portion of the fruits. This is wrong and should not continue. To secure to each laborer the whole produce of his labor as nearly as possible, is a worthy object of any government.

"For your information," the ILA said to Sanborn, "this is not instruction from Moscow. This is a quotation from an American, an American President to be exact, Abe Lincoln."

—*From* Workers on the Waterfront, *1988*

sensational newspaper headlines. The investigations led to the arrest and conviction of several ILA officials and the imposition of fines on both ILA locals and the national union. It also led to changes in waterfront hiring procedures and financial oversight.

In retrospect, it appears the investigations sometimes violated norms of legal procedures. Futhermore, some of the investigators used the proceedings to grab for headlines and further their own political fortunes. However, corruption on the waterfront was undeniable. Even an author sympathetic to the ILA estimated that perhaps 10 of the 70 locals in the port had been gangster-controlled at one time or another.

The AFL dropped the ILA from affiliation and even started a rival union, the International Brotherhood of Longshoremen (IBL). With Teamster support and police protection, the IBL sought to break the ILA's hold on the Hudson River and Brooklyn piers, and a series of bloody skirmishes occurred in 1954 when IBL members attempted to cross ILA picket lines. However, the ILA made changes in leadership at both the national and local levels and won a narrow victory in a bitterly contested election in New York. By the end of the decade, it had been readmitted to the AFL-CIO.

Containerization

The 1960s brought a development that profoundly and permanently altered the nature of dock work—containerization. Heretofore, all general cargo (cargo other than commodities that are shipped in bulk, such as oil, coal, and grain) had been handled "breakbulk" style. Since freight was usually handled one parcel at a time, the process was labor-intensive. At the docks, each crate would be hoisted by cargo net and crane onto the ship. In the ship's hold, each parcel had to be precisely positioned and then braced to protect it from damage during the voyage. All this was the work of stevedores.

The introduction of standardized ocean containers—essentially truck bodies with locking mechanisms at each corner to attach them to chassis, railcars, or other containers—had enormous advantages for the ocean carrier and the shipper. Previously, a gang of about 20 longshoremen could load perhaps 20 tons an hour. Now one crane and maybe half that many men could load a container holding 20 tons every two or three minutes. Breakbulk freighters often took a week to unload and reload. A containership might take only four to six hours. Less time in port meant lower port costs and faster circuits. Faster circuits meant a ship line could carry the same amount of cargo to the same destinations using fewer vessels.

For the cargo owner, less handling meant less chance of damage to the cargo. There also was much less pilferage, since containers could be sealed when they left the factory and not opened until they reached their ultimate destination. Packaging did not have to be as sturdy, and since the packages were lighter, they cost less to ship.

Now, far fewer dockworkers were needed, and the skills required were different. Instead of men with manual ability and physical strength, the demand was for workers who could operate and maintain the sophisticated and expensive heavy equipment that moved the containers, and for "white collar" employees—women as well as men—who could collect, transmit, and utilize information about the containers.

The longshoremen had struggled for a century and had finally achieved good wages and benefits and economic leverage. They were understandably reluctant to accept these changes.


Yesterday...
MARLON
BRANDO
On The Waterfront
...and today

Collective bargaining over work contracts became particularly contentious again and was punctuated by dock strikes. Gradually, however, accommodations were reached. Generally, work rules, gang sizes, and compensation remained as they had for handling break-bulk cargo, even though this often meant oversized gangs and highly paid but underutilized workers. In the name of "work preservation," so-called "50-mile rules" were negotiated that reserved all "stuffing and stripping" of containers in or near port cities for unionized longshoremen. Similarly, agreements were negotiated with the major ship lines that required them to use union labor at every port of call. Workers with sufficient seniority became eligible for a guaranteed annual income program, which assured them a comfortable living regardless of the number of hours they worked.

Jobs along the docks declined dramatically, even though the emergence of a truly global economy led to a sustained increase in the amount of general cargo. From 1970 to 1986, the number of dockworkers on the rolls in the Port of New York-New Jersey fell from 30,000 to 7,400 and the manhours worked dropped from 33 million to 11 million.

Dock Work Today

Today dock work is full of contrasts and ironies. For one thing, affluence coexists with under- and unemployment. Straight-time pay in ILA East Coast ports is $18 an hour, and in busy ports workers with seniority often get much more than 40 hours, with time-and-a-half pay for overtime, night, and weekend work. Thus, in the Port of Hampton Roads last year, 130 longshoremen earned more than $62,000. At the same time, ILA members in some ports had not worked at a marine terminal in months.

Many longshoremen are performing difficult jobs that require intellect, great dexterity, and courage (for example, as shipside crane operators and repairmen, container lashers, stowage planners, and computer workers). For some, responsibility has increased dramatically: dropping a crate of break-bulk cargo might cause $1,000 in damage. Dropping a loaded container can destroy $100,000 worth of cargo and endanger a $5 million port crane. Meanwhile, other longshoremen are fighting boredom, doing jobs better done by machines, or spending too much of their time watching other people work because gang sizes are too large.

The 1980s have seen four momentous changes in ocean shipping:

- intensified competition between ports and between carriers, caused in part by federal deregulation;
- the growth of intermodalism and, with it, the shift of some cargoes to trains and planes;
- the widespread adoption by businesses of "just-in-time" inventory techniques;
- and the application of advanced computer and communications technologies.

These changes have imposed new pressures on dockworkers and their unions—to improve efficiency and reduce labor costs; to adopt new approaches regarding work schedules, pay scales, and job jurisdictions; and to provide people capable of operating the new technologies of the marine terminal.

As this article goes to press, the ILA and the shipping associations of the Eastern and Gulf coasts have failed to negotiate a new multiyear contract. Instead, they have agreed to extend the existing master contract, in effect postponing decisions on wages, hours, manning levels, gang structures, and retirement benefits. This comes at a time when nonunion and non-ILA workers have reappeared in some seaports. Thus, it appears that developments during the next 14 months may well determine not only *how* the work on the docks is done, but even perhaps, *who* does it in the years to come. □

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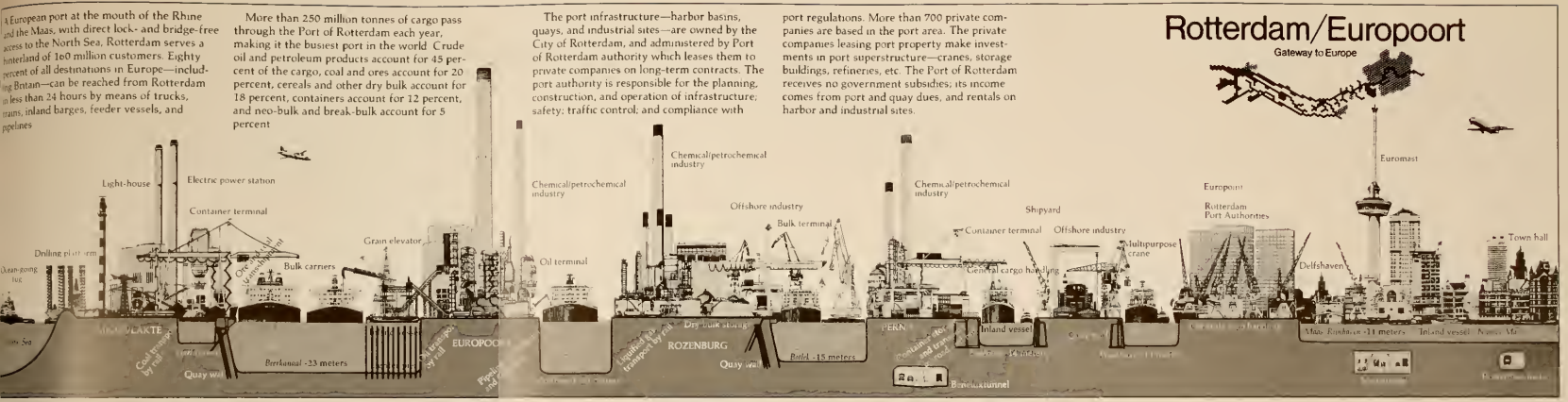
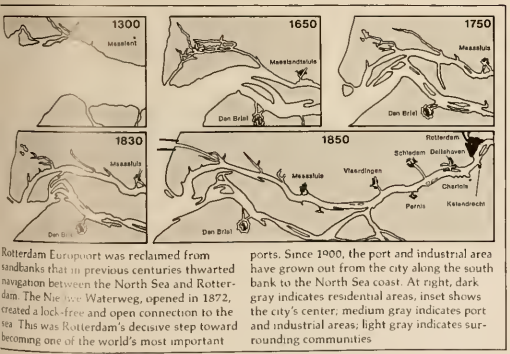
A European port at the mouth of the Rhine and the Maas, with direct lock- and bridge-free access to the North Sea, Rotterdam serves a hinterland of 160 million customers. Eighty percent of all destinations in Europe—including Britain—can be reached from Rotterdam in less than 24 hours by means of trucks, trains, inland barges, feeder vessels, and pipelines

More than 250 million tonnes of cargo pass through the Port of Rotterdam each year, making it the busiest port in the world. Crude oil and petroleum products account for 45 percent of the cargo, coal and ores account for 20 percent, cereals and other dry bulk account for 18 percent, containers account for 12 percent, and neo-bulk and break-bulk account for 5 percent

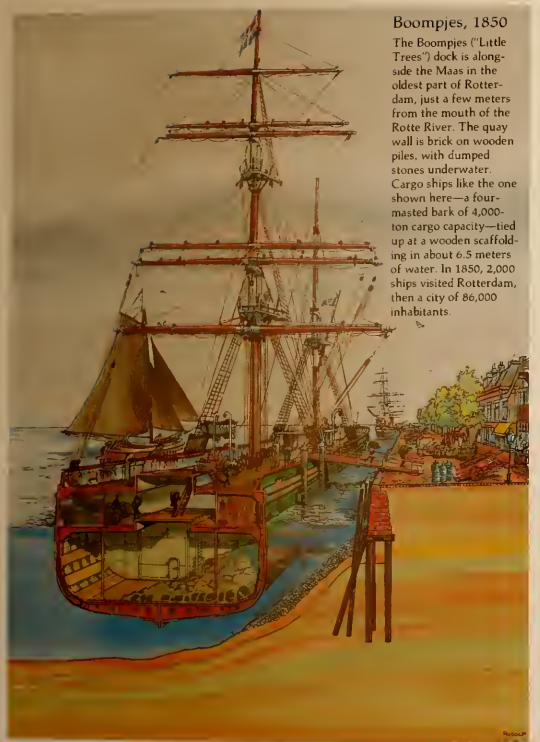
The port infrastructure—harbor basins, quays, and industrial sites—are owned by the City of Rotterdam, and administered by Port of Rotterdam authority which leases them to private companies on long-term contracts. The port authority is responsible for the planning, construction, and operation of infrastructure; safety; traffic control; and compliance with port regulations. More than 700 private companies are based in the port area. The private companies leasing port property make investments in port superstructure—cranes, storage buildings, refineries, etc. The Port of Rotterdam receives no government subsidies; its income comes from port and quay dues, and rentals on harbor and industrial sites.





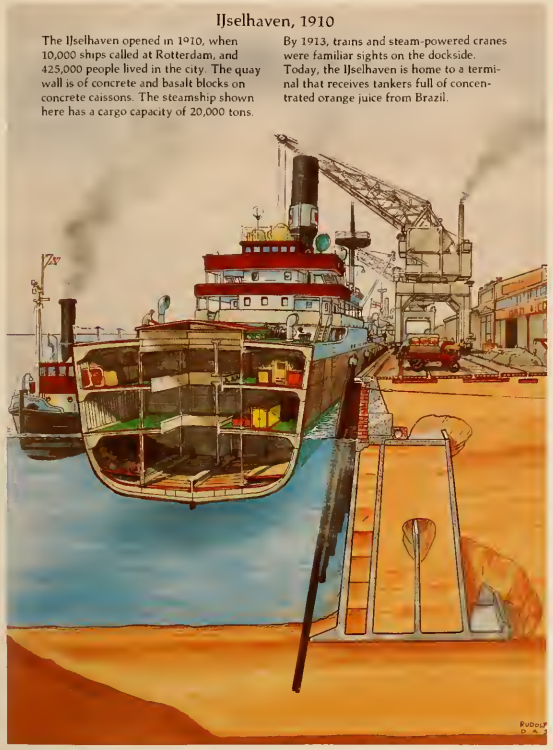
Rotterdam Europoort was reclaimed from sandbanks that in previous centuries thwarted navigation between the North Sea and Rotterdam. The Nieuwe Waterweg, opened in 1872, created a lock-free and open connection to the sea. This was Rotterdam's decisive step toward becoming one of the world's most important ports. Since 1900, the port and industrial area have grown out from the city along the south bank to the North Sea coast. At right, dark gray indicates residential areas, inset shows the city's center; medium gray indicates port and industrial areas; light gray indicates surrounding communities

THE EVOLUTION OF SHIPS AND DOCKS IN ROTTERDAM



Boompjes, 1850

The Boompjes ("Little Trees") dock is alongside the Maas in the oldest part of Rotterdam, just a few meters from the mouth of the Rotte River. The quay wall is brick on wooden piles, with dumped stones underwater. Cargo ships like the one shown here—a four-masted bark of 4,000-ton cargo capacity—tied up at a wooden scaffolding in about 6.5 meters of water. In 1850, 2,000 ships visited Rotterdam, then a city of 86,000 inhabitants.



IJselhaven, 1910

The IJselhaven opened in 1910, when 10,000 ships called at Rotterdam, and 425,000 people lived in the city. The quay wall is of concrete and basalt blocks on concrete caissons. The steamship shown here has a cargo capacity of 20,000 tons.

By 1913, trains and steam-powered cranes were familiar sights on the dockside. Today, the IJselhaven is home to a terminal that receives tankers full of concentrated orange juice from Brazil.

Eighth Petroleumhaven, 1984

The 8th Petroleumhaven, located on the Maasvlakte, has a water area of 54 hectares and a depth of 24 meters. The quay wall is of concrete box construction on concrete stakes that also support rails for the rolling bridge cranes. It also is anchored rearward (not shown) by steel piles. The container ship shown here has a cargo capacity of about 25,000 tons.

ROTTERDAM

Quays to the Heart of Europe

by T. M. Hawley

The Goeree Light Platform radar station is the first visible sign of the Port of Rotterdam for the 32,000 seagoing ships that make their way there each year. Into the beacon's 70-kilometer radius come the largest cargo vessels in the world: ultra-large tankers, dry bulk carriers, and container ships carrying the equivalent of 3,500 semi-trailers of cargo.

A container ship, with a beam of more than 40 meters and drawing more than 20 meters, heads for the Europahaven. From there, its cargo will be dispersed and transshipped to places such as Stockholm, Basel, and Vienna—more than 250,000 inland and feeder vessels call at Rotterdam each year—and arrive at those places within a few days. With thousands of people working 24 hours a day in the tugs and cranes, at computer terminals and offices—overseen by port, city, and trade bureaucracies that work together better than most—Rotterdam is, in terms of total cargo tonnage, far and away the busiest port in the world.

Rotterdam owes its position as the world's premier port to its link with the Rhine River and Germany's industrial heartland of the Ruhr Valley; but until a little more than 100 years ago its connection to the North Sea was a slow-moving, shallow river with dangerous, shifting dunes at its mouth—a treacherous stretch of coastland. Before the 1870s, seagoing ships reached the Rhine from the North Sea by way of the Hollands Diep. Rotterdam received its overseas trade by this route, coming into the city from the east after passing through the busier

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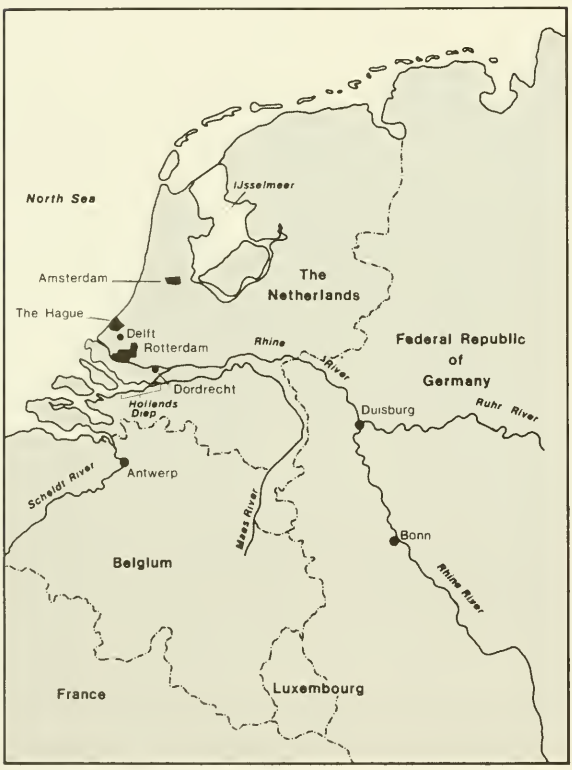
Rotterdam is Europe's leading container port. (Photo by Bart Hofmeester)

port of Dordrecht, but even then the importance of trade to Rotterdam was evident in the names of the quays at the center of town: The Oude- and Nieuwehaven (Old and New Dock), Beer Dock, Wine Dock, Salmon Dock, and Shipbuilders' Dock. The Railway Dock was a new development back then.

In 1872, after six years of digging and dredging, Rotterdam opened the Nieuwe Waterweg, which gave the city its definitive connection to the North Sea. Pieter Caland directed the project. He was a young civil engineer who had studied how the Scottish and French managed to keep the mouths of the Clyde and Garonne from silting up. He made what was then the most extensive study ever of tidal currents in the various mouths of the Rhine and Maas, and developed a plan that would redirect their flows and cut through the dunes near Hoek van Holland. By 1880 the success of the project was obvious; and since that time—despite the Depression, Nazi bombings, and oil and labor crises in recent years—the people of Rotterdam have seen and done what is necessary to make and keep their port a focus of world shipping and trade.



The Rhine is navigable to the Swiss-German border at Basel. Rotterdam is the Rhine's link to the sea.

The emphasis on work in the port city was such that the Dutch often said "you earn your money in Rotterdam, and go to Amsterdam to spend it." But the Rotterdammers one meets at cafés and theaters seem perfectly happy to leave the "museum-city" to the north for the tourists.

Elephants at the Delta Terminal

About half-way between the Goeree Platform and Hoek van Holland, the container ship picks up a Port of Rotterdam pilot. The pilot maintains radio contact with the outermost of the Port's three traffic centers, at Hoek, which collates data from eight radars and controls traffic around Europoort and up the Nieuwe Waterweg. He advises the captain of the ship on the best approach into the Europahaven and the Delta Terminal.

The Europahaven is about 35 kilometers downstream from the Oudehaven, and is part of the Maasvlakte area, built between 1965 and 1973. At the Delta Terminal—leased and operated by Europe Combined Terminals (ECT)—if three cranes were to work on the ship at once, under ideal conditions the ship could be completely unloaded, and reloaded with 3,500 new containers in about 50 hours. The similar operation in a typical U.S. port would take about 80 hours.

These cranes are among the largest in the world, able to reach across 40 meters and so service the largest container ships afloat without having them turn around. The crane operators sit in gondolas 30 meters above the quay, where they oversee the cranes' motions via computers and video monitors. Actually, each of these cranes is two cranes in one. While one "spreader" is moving a container from the ship to an intermediate platform, a second spreader moves the previous container from the intermediate platform to one of the seven chassis of a trailer system that carries containers from the cranes to the next item of heavyweight high-tech gadgetry, the straddle carrier.

The straddle carriers are affectionately known as "elephants" at the Delta Terminal, since these massive vehicles are the primary beasts of burden there. As their official name

The World's Busiest Ports

Numbers represent 1985 totals for 1,000s of tonnes of foreign and domestic cargo handled, except for Rotterdam which reports only foreign traffic. (From the Institute of Shipping, Economics, and Logistics, Bremen, West Germany, 1987)

Tubarao, Brazil	Osaka, Japan	Antwerp, Belgium	Marseille, France

implies, they straddle parked containers, pick them up, and transport them to and from the container storage, or stacking, yard. The elephants' mahouts are perched 20 meters above the pavement, where they have a good long-range view, but cannot see what's going on directly beneath them, so they are guided around the stacking yard by a grid of infrared lights embedded in the pavement. These lights are connected to one of ECT's computers, and using the same technology as a video remote control, they flash information to the drivers' video screens indicating their location, destination, and the route they should be following. When a trucker comes to the Delta Terminal to pick up a container, he uses a magnetic key card system to tell the straddle carrier driver which container he has come for, and where he is waiting for it.

ECT was the first stevedoring company in Rotterdam to specialize in containerization, in 1967, and its two terminals and 22 cranes at the port now combine to handle an average of more than 120 containers an hour. Within the next few years, ECT will implement an automated system of container movement at the Delta Terminal that will move the boxes from the quay by means of unmanned vehicles and deliver them to automated stacking cranes, which will in turn follow computerized instructions and place them at preassigned spots in the stacking yard.

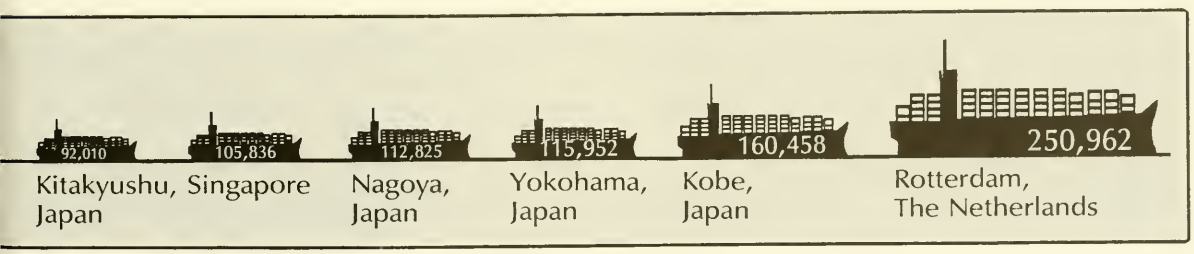
Unemployment is a problem in Rotterdam, and the port's commitment to containerization—it ranks second in the world, behind Hong Kong, in container tonnage handled—has added to the strain. While the city and the port have been beehives of construction projects ever since the end of World War II, workers with outdated skills have found themselves joining unskilled immigrants from Holland's former colonies in queue for benefits at City Hall. That unhappy line lengthened when gangs of stevedores had their work taken over by a herd of efficient and tireless Goliaths with digital brains and sinews of steel and wire. The continuing problem was eased to a degree when ECT restructured its work shifts and reduced the workweek; these innovations allowed more people to stay on the payroll, and set an example that stevedoring companies in the United States have followed.

The petroleum storage tanks at Rotterdam are linked by pipeline to 14 refineries in Belgium, the Netherlands, and West Germany. (Photo by B. Hofmeester)

Industrial Landscapes and Lace Curtains

A bargeman looks out a lace-curtained cabin window as his boat is moored near the end of the Hartelkanaal, the ultimate terminus of inland cargo traffic on the Rhine; he'll be carrying containers full of Japanese electronics to Basel, Switzerland. Bargemen like this one move cargo on the Rhine much as truckers move cargo on U.S. superhighways, but with a European difference: the window through which he watches the last container lowered aboard is adorned not only with lace curtains but a window-box full of nasturtiums as well. A few minutes later he pats his dog and embarks on his Rhine journey. The barge rounds the first bend in the canal, and a landscape comes into view that begs for a Hollywood-inspired chase scene or terrorist drama—Rotterdam Europoort.

Europoort was built during the 1960s, and



The cars of the multi-trailer system employed at ECT's Delta Terminal have computer-controlled steering, allowing each car to follow precisely the path of the car preceding it. (Photo © by Photo Sea Sky Martin)

is sandwiched between the Hartelkanaal and the Calandkanaal 20 to 30 kilometers from the Oudehaven. It is, in a sense, a monument to the importance of oil to the Port of Rotterdam. Four sprawling petroleum terminals are there, as is a stretch of refineries operated by British Petroleum, Shell, Exxon, Texaco, Kuwait Petroleum, and Mobil. Between 75 and 80 million tonnes of oil are imported into Rotterdam each year, where it is stored and refined in petro-industrial labyrinths like Europoort. Three pipelines tap the products of the refineries: one, with a capacity of 20 million tonnes a year, runs to the Federal Republic of Germany; the second, which can carry 39 million tonnes a year, runs to Antwerp; and the third carries aviation fuel to Amsterdam's Schiphol Airport.

Oil imports reached their peak in 1975, when 103 million tonnes were received. Since that time, imports from the Middle East have dropped to about half of what they once were, while British and Norwegian imports have nearly tripled. Twenty years ago, the petroleum giants leasing Europoort property thought that the boom would never end, and today find themselves renting many more hectares than they can use. Middle Eastern oil is increasingly refined prior to export, but Rotterdam's refining and storage capacity, and its pipelines, will continue to be used. The immense tankers that once carried crude into the port will soon be bringing in refined petroleum which will need further refining and blending before it goes into the pipelines and onto other barges plying the Rhine. So even though the refineries may have overreached a bit in former years, the port has kept them a vital and central part of the Rotterdam scene. Another factor keeping the petroleum business in town is the establishment of an oil futures exchange.

The refineries and other chemical industries in the port have been looked at askance when weather conditions combine with their waste gases and particulates, and smog settles around Rotterdam. Two villages surrounded by the port—Rozenburg and Pernis—have at times expressed strong concern over environmental and safety issues; and Rozenburg has even succeeded in having the port reallocate the north side of the Brittanniëhaven for general cargo handling when residents opposed planned chemical-plant expansion there.

The flow of VCRs and CD players packed into the bargeman's containers, along with the flow of all the cargo moving through the Port of Rotterdam, is mimicked by a flow of information in computer memories. The various clients of the port developed individual computer systems to help them in their particular tasks, but the fact that many of these systems could not "talk" with each other presented a problem since these clients often work together.

To facilitate the telecommunication of shipping information among clients—whether they're located in Bonn or Bangkok—the port set up a private company, International Transport Information System (INTIS). The company's computers are connected to the IBM international network and the General Electric Information Systems, and use the United Nations International Standards for Electronic Data Interchange. INTIS's solid-state laser and fiber-optic network gives subscribers the signal strength and bandwidth necessary to work together at new degrees of intimacy, which allow the concept of "just-in-time" delivery to become a reality. Voice, data, text, and images can be received, sent, and relayed through the network.

On-line information on world commodity markets and market indices also are provided through INTIS, enabling manufacturers to use the transport chain as a means of stock control and respond to rapid changes in their markets.

Like the oil futures exchange, INTIS is an example of how Rotterdam is considering the post-1992 European Community, and seeking to transform itself from "merely" the busiest port in the world to a major center of European business and distribution. Port officials see that economic growth through increased tonnage—experienced in a big way with petroleum until the 1970s, and now with containers—has limited possibilities. So "Rotterdam DistriPark" is now being built on a 35-hectare tract where new companies will stuff and strip containers, prepare imported autos for delivery to dealers throughout Europe, and provide other value-added services to customers of the port. Having access to the teleport facilities of INTIS makes keeping track of high volumes of goods and orders a realistic possibility.

Municipal officials are doing what they can to make the city an attractive place for corporate relocations. The hoped-for transformation from an "all work, no play" city to a business and cultural powerhouse is symbolized in a sculpture near a museum of maritime history in the center of town. Ossip Zadkine's "The Ruined City" was a response to the Nazi air raid of 14 May 1940, that left a 260-hectare wasteland where downtown used to be, and killed hundreds. A monumental figure, its chest torn out, raises its outstretched hands to the heavens vowing to do what it can to regain its heart. With the startling architecture of the rebuilt city center, film and poetry festivals, and a variety of other cultural and social opportunities, Rotterdam is becoming less a city attached to a port, and more of a city with a port. The point is driven home by the many upscale bridal, maternity, and infants' shops one sees while strolling through town.

The Calandbrug Wind Wall cuts the force of heavy winds, permitting a higher traffic flow through the port. (Photo by the author)

Eliminating High Winds and False Echoes

As the bargeman moves up the Hartelkanaal, the hardware of the port and refinery business disappears behind greenery that is a stage for grazing herds of sheep, picnickers, European-style sun-bathers, and tractors harvesting hay. A stretch of parkland between the Hartelkanaal and the Brielse Meer holds a nine-hole golf course, with nothing in view but the typical trees, grass, sand, and water with nesting ducks and seabirds. At the east end of Europoort, even the port's functional anatomy can be mistaken for modern art: a 1,600-meter "wind wall" in the vicinity of the Calandbrug ("Caland bridge") leaves you wondering if Christo* visited Rotterdam, and abandoned his usual fabric in favor of monumental quantities of concrete. The wall consists of about 100 slabs of concrete, some rectangular, some semicylindrical, 10 to 18 meters across, reaching 25 meters above the canal's banks. The Calandbrug was too narrow for ships to negotiate in winds of force seven or eight, and the wall reduces those winds to about force five, allowing the traffic to flow more regularly.

By the time the bargeman has come to the end of the Hartelkanaal, he has entered the middle of Rotterdam's three Vessel Traffic Management System (VTMS) zones. This zone is named "Botlek," after the main harbor basin in the region. The VTMS is a model for other major ports around the world, and became operational in April 1987, replacing the chain of radar stations

*A California-based artist whose large-scale, temporary works wrap monuments and landforms in vast quantities of textile fabric.

set up in 1956. From the Goeree Platform to the van Brienenoordbrug at the eastern edge of the city, traffic through the port is monitored in much the same way that air traffic is controlled in the vicinity of busy airports. But while air traffic is really controlled, the VTMS is more of an advisory authority, even though the largest ships in port and those carrying hazardous cargoes must have a certified Port of Rotterdam pilot aboard.

The "Automatic Tracking System" is the brain of the VTMS. It provides traffic managers with a computerized image of their management area, synthesized from all the radars working in that area. The managers picking up our Rhine barge, for instance, see an image that combines information from nine radar beacons, since Botlek is a center of dangerous cargo traffic. False echoes are thus eliminated, and managers still see the images of ships that would be hidden from a single beacon. The system calculates the size of the ships, and displays them proportionately on a screen that is updated every three seconds. By touching the image of the barge with a light-pencil, a manager accesses detailed information about the actual barge—its bearing, speed, temporary identification number, whether it is channel-bound or carrying hazardous cargo, and so on. He can also see one-minute and three-minute projections of any ship's position, the distance between the ship and any other object on the screen—including other ships—and the point and time of closest approach between two ships at the Hoek van Holland center.

By 1991, improvements to the VTMS data base will allow a direct identification of all ships in the port, without using Port of Rotterdam identification numbers. The ships' on-screen images will then be based on their actual dimensions, not on sizes calculated from radar data. All pertinent information about a ship—its name, its type, its destination, whether a pilot is aboard, if it is carrying dangerous cargo, and administrative and fixed data—will be accessible to managers through their light-pencils.

New Land for Dredge Spoils and Sunbathers

The dangerous cargoes of solid and liquid chemicals in the Botlek and elsewhere pose an obvious environmental threat, as do the refineries downstream; but these threats are limited somewhat by strict safety procedures and practices. The stickiest environmental problem for the port is what to do with contaminated dredge spoils.

The Port of Rotterdam dredges 23 million cubic meters of silt each year just to stay in business, and more than 40 percent of it is too toxic for disposal in the North Sea. This heavily polluted silt consists largely of tiny soil particles with heavy metals and long-lived organic compounds adhering to them. The pollutants derive to some extent from port activities, and the port is working to curb these activities or limit their polluting aspects; but the Rhine carries much of the pollution into the port, as it drains perhaps the most industrialized watershed of its size on Earth. Rotterdam has identified many of the heavy polluters upstream, and is working to ensure they clean up their effluents and pay a fair share for removing this hazardous waste from the port's waterways.

In the meantime, the toxic silt has to go into long-term storage. After a lengthy environmental impact study, the "Slufterdam Project" got under way in May 1986, in the Maasvlakte area. The project consisted of digging a hole 28 meters deep and building a ring-dike 23 meters high to enclose an area of 260 hectares on land reclaimed from North Sea. It was finished in less than a year-and-a-half.

By 11 years from now, it will be full. And while there are ideas in the air about how and where

Barges carrying goods to and from the Port of Rotterdam are a familiar sight on the Rhine.

to do it all over again, the cost of repeating the Slufterdam Project is something that no one really wants to face. Instead, discussions and negotiations continue at various levels to do what is possible, as quickly as possible, to clean up the Rhine.

The project has been successful for other reasons besides the long-term storage of dredge spoils. When one stands at the top of the ring-dike, looking out to sea on a fine summer's day, one sees a parking lot full of cars in the foreground and a beach full of sun-loving Netherlanders down below. And with the sides of the dike planted in dune grasses and rugosa roses, the views from the parking lot and beach don't reveal the reason for the land being there.

Above, Rotterdam's Oudehaven with The White House at left and the Cube Houses at right (Photo courtesy of Fotoburo Henk Timmer). Below, "The Ruined City" statue with the Prins Hendrik Maritime Museum in the background. (Photo by Marco de Nood)

Through the City's Heart and Up the Rhine

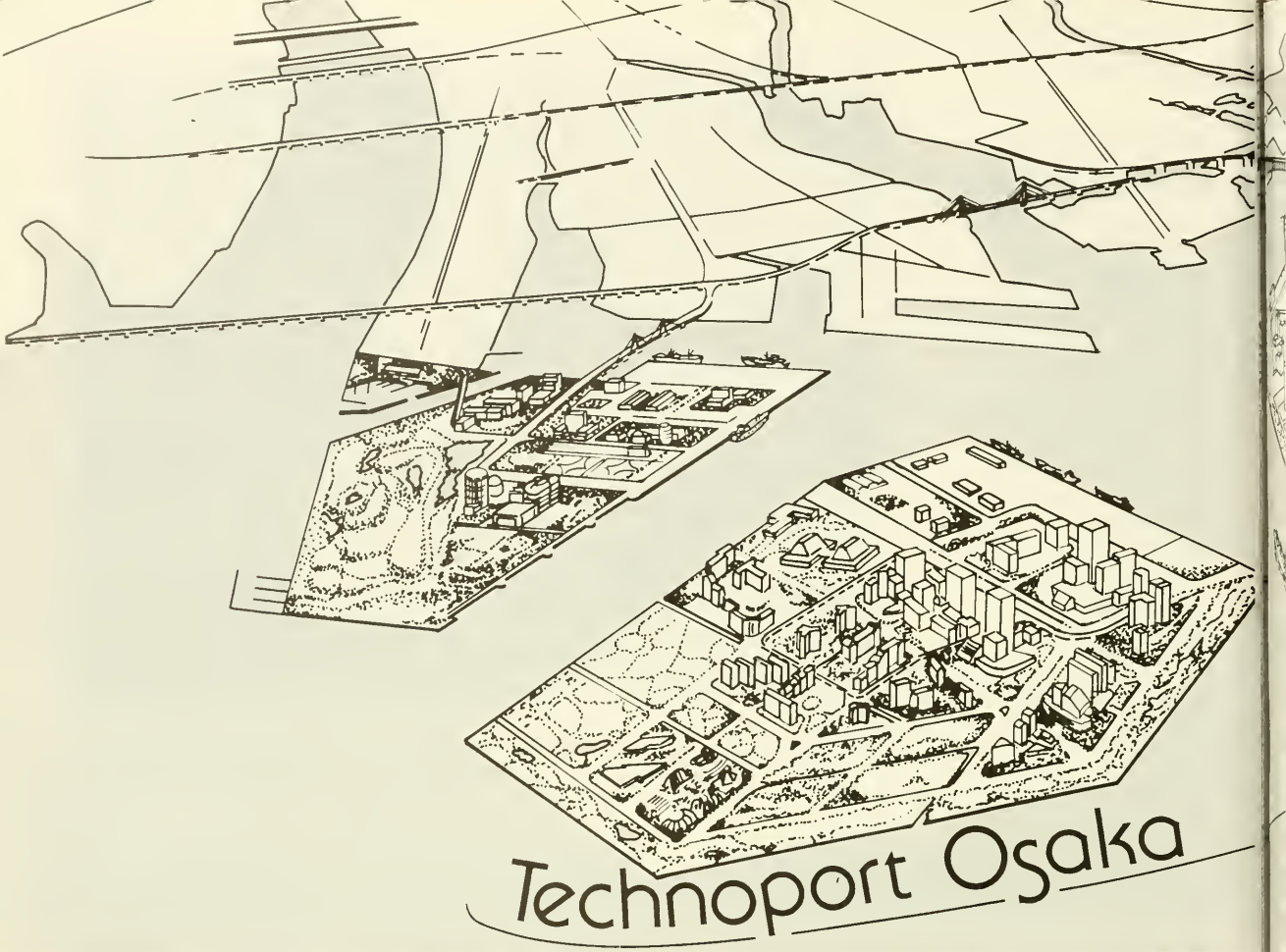
The bargeman is well on his way up the Nieuwe Maas by now, and four kilometers downstream from the Oudehaven, he passes the Waalhaven on his right. This harbor basin was dug between the wars, almost entirely by hand. It remains today the largest harbor basin in the world excavated in exchange for sweat and tired muscles, a testament to Rotterdammers working together to make their port work.

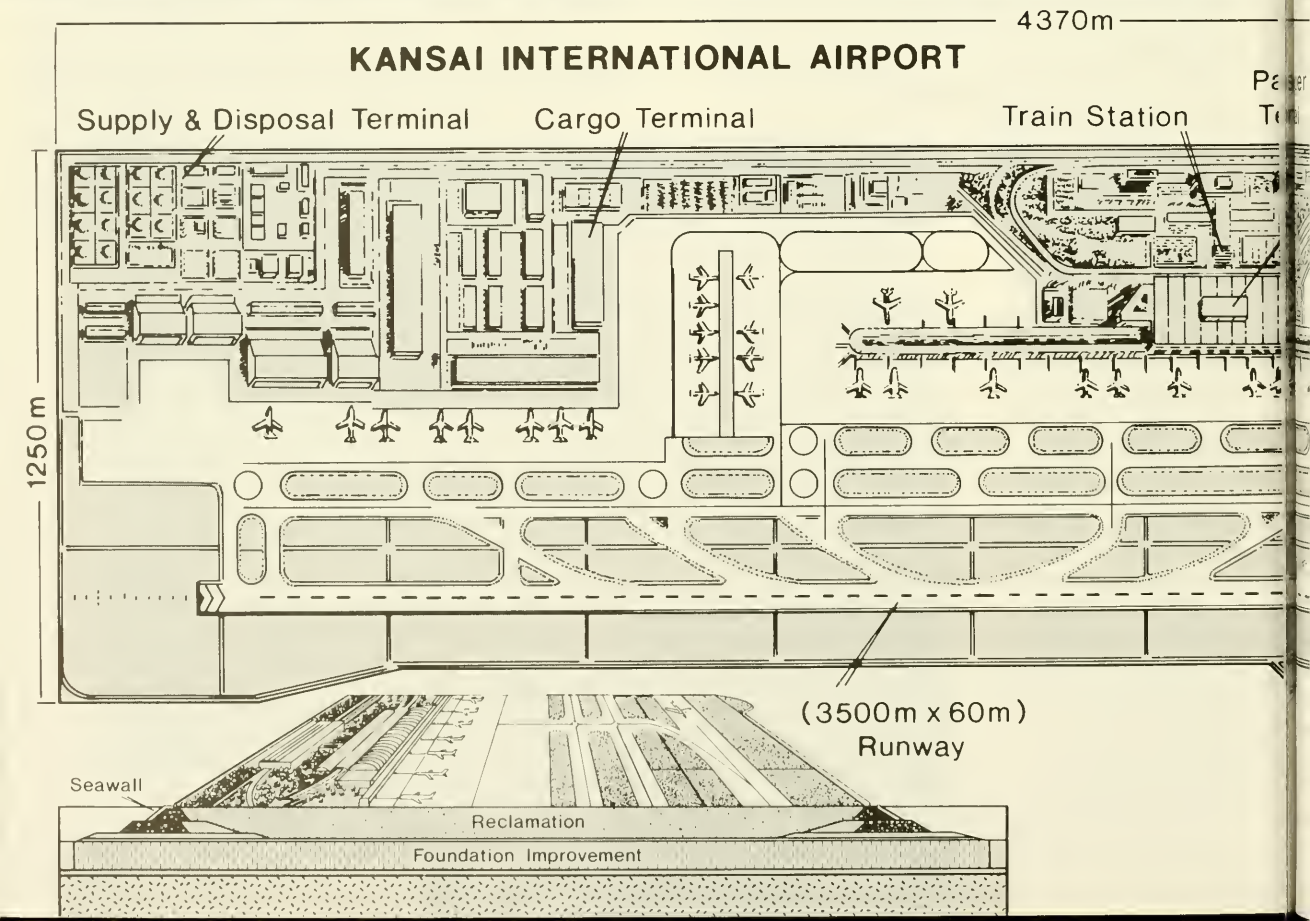
Another bend in the river brings one of Rotterdam's startling downtown landmarks into view—the Willemsbrug. And while chugging toward the bridge, reminiscent of Picasso's sculpture in downtown Chicago, the bargeman's vessel slips into and out of the view of a couple enjoying an apéritif in a café on the Spaansekade, or "Spanish Quay." Around the Oudehaven immediately before them, all of old and new Rotterdam come together and blend in a way not possible downstream at Europoort. The contrast of ECT's giant cranes to the sunbathers, and the antique sailing barges across the Oudehaven to the cube-shaped apartments off to the right, aren't quite so sharp when you consider that the dignified, 11-story building across the way, "The White House," was Europe's first skyscraper—for a time, the tallest building on the continent.

The couple exchanges pleasantries with their waiter as they pay their bill. He wishes them "alle besten" as the bargeman heads for Switzerland. □

Acknowledgments

This article was prepared from interviews with the Port of Rotterdam's Secretary General Robert T. Sperling, Telematics Expert Roel H. Chaudron, Nautical Systems Division Manager Jan C. M. de Keijser, Environment, Safety, and Port Planning Expert Mathieu J. K. Heinen, Technical and Managerial Port Assistance Office Director C. Bert Kruk, Research and Development Economist Jan van der Zande, the City of Rotterdam's Head of Ports and Transport Theo M. Schut, and Europe Combined Terminals' Marjilde Pors. I am also grateful for the assistance of the Port of Rotterdam's Office of Public Relations, especially that of Philip Brink and Mariane Roelofs.


Technoport Osaka


4370m
KANSAI INTERNATIONAL AIRPORT
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Seawall
Reclamation
Foundation Improvement

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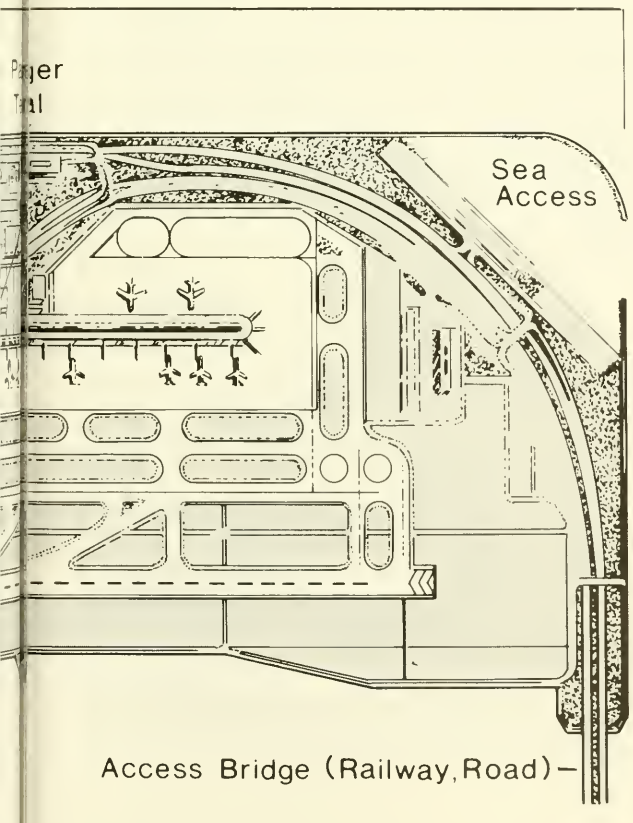

Reberth of a Nation

by Paul R. Ryan

A major change is presently under way in the industrial structure of Japan – a change that is forcing a major revamping of two of the country's major ports and bays – Tokyo and Osaka. The once-strong emphasis on exports is shifting to imports as an affluent government deals with an expansion of domestic demand coupled with a cultural proclivity for relying as little as possible on foreign heavy industry.

The best examples of Japan's planning for the 21st century – in which the world will be a far smaller place because of recent improvements in transportation and communications systems – are the Technoport Osaka Project and the Kansai International Airport. Both of these projects,

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along with the planned restoration of Tokyo Bay, receive science and engineering support from the Ports and Harbor Research Institute of the Japanese Ministry of Transportation.

Japan is a small—about the size of the State of California—crowded nation of 140 million people. It has few natural resources. Much of its land is mountainous and therefore unlivable. It is a nation that looks to the sea for expansion, recreation, and food. In Japan, the utilization of space is an art form.

The Technoport Osaka Project

City fathers, industrial leaders, academics, and government officials in the Kansai region of Japan, which includes the City of Osaka, have come together with a vision that calls for the revitalization of the local economy so that it, along with Tokyo, can lead Japan into the new Pacific age.

The basic plan for the Technoport Osaka Project was framed in July 1988. It calls for the concentration of research institutes and experimental facilities for the development of new techniques, products, and systems in electronics, biotechnology, new materials, and other fields, along with the construction of support facilities. At the same time, the Port of Osaka will be renovated to create a general distribution center for international and domestic land, sea, and air transport.

The plan also calls for introducing the latest in information technology. A teleport will be constructed that will be a center of international and domestic satellite communication, using fiber optics and other techniques, along with a digital networking system.

The Japanese believe information-related businesses have great growth potential. International conference facilities, world-class hotels, sporting grounds, concert halls, and theaters will grace Technoport Osaka, all built on four artificial islands in the bay. There also will be suitable housing available and a marine museum. The completion of the project is scheduled for 2010. The cost is estimated at 900 billion yen in the public sector and 1.3 trillion yen in the private sector ($6.44 billion and $9.30 billion). The port will be divided into commercial, residential, and tourist districts, with a total daytime population of 200,000. The working population would be 92,000, with housing for 60,000.

Some land reclamation for the project actually began in 1985. Some construction will begin in 1990 with all land reclamation to be completed by the year 2000. If all of this has the sound of a pipe dream, consider that the nearby city of Kobe more than 15 years ago dug out the side of a nearby mountain, made an artificial island out of it beyond the water's edge, built a complex of hotels and conference centers serviced by a nifty robotic train, put berths all around the island's outer edge, and came out with one of the world's largest and busiest container ports. All this was done by an enterprising mayor with little backing from the Japanese government.

The Kansai International Airport

The Kansai International Airport will be constructed on the world's first artificial offshore island for this purpose, which is presently under construction and is scheduled for completion by 31 March 1993. The island is being created in approximately 18 meters of water, five kilometers from the mainland in Osaka Bay. Similar artificial islands are planned for other locations around the nation.

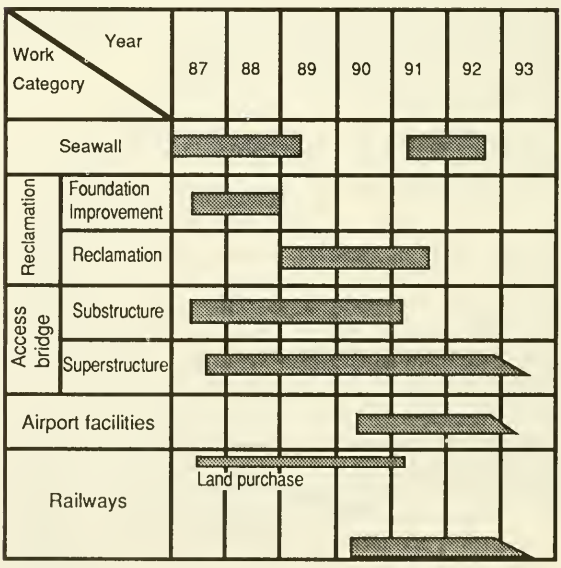
Both the island and the airport are being built by a private corporation at a cost of one trillion yen ($7.15 billion) in 1983 prices. The corporation was created by a special act of the Diet, the Japanese legislature. The airport will initially cover an area of 5.11 million square meters, with room for expansion to 12 million square meters.

The airport will be open to cargo and airline traffic 24 hours a day. The island will be accessible by bridge and boat, with train service located in front of the passenger terminal. It is estimated that the airport will handle about 160,000 takeoffs and landings a year. The main runway will be 3,500 meters long.

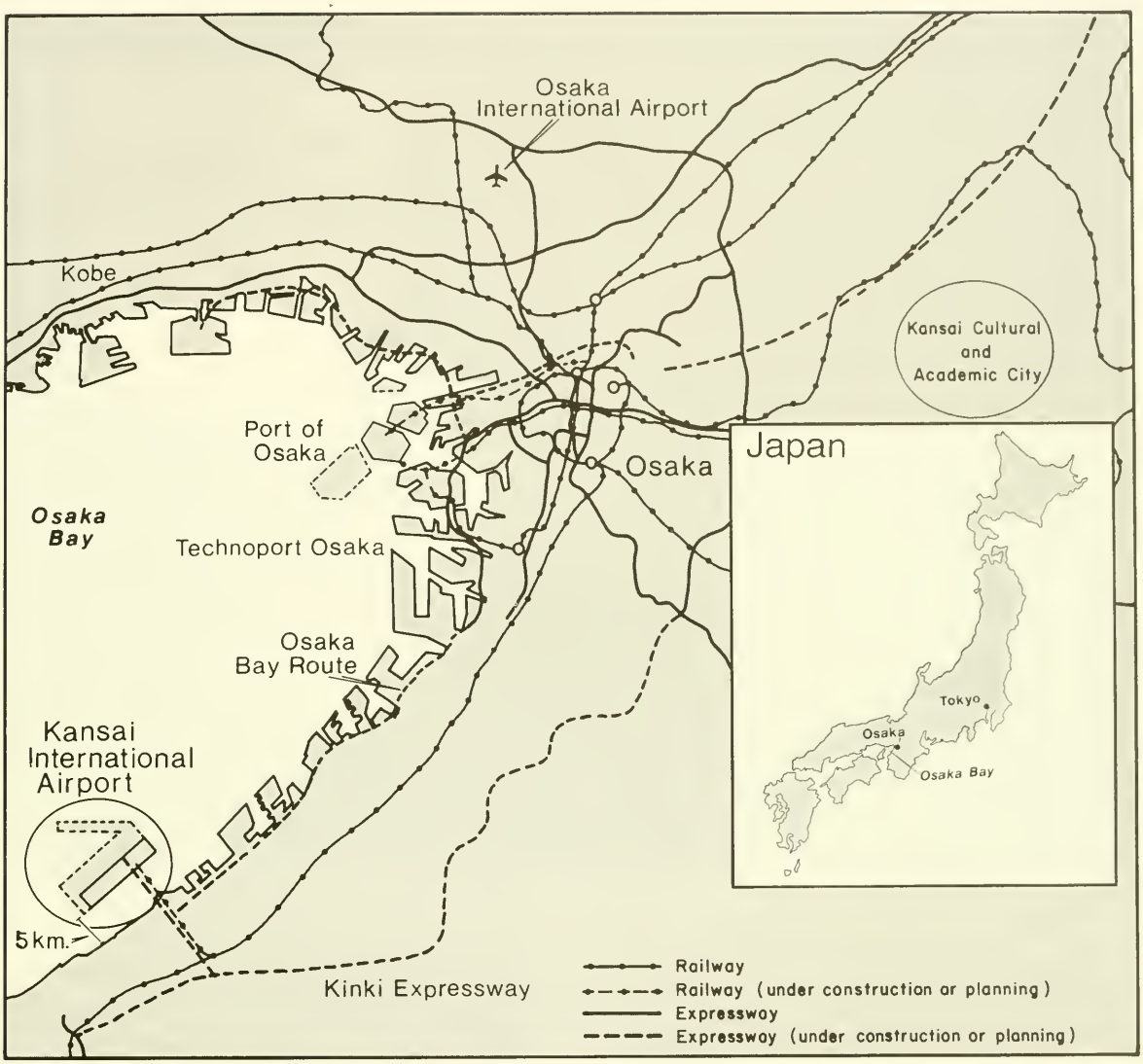
Geologically, a weak alluvial clay layer exists at the top of the seabed over which the island is being built. Under the clay layer, gravel layers and diluvial clay layers alternate to a depth of hundreds of meters.

Because of its location in Osaka Bay, the island will be subjected to waves no higher than 50 centimeters for about 80 percent of the year. The seawalls, however, have been designed to

Construction Schedule



Construction schedule for the Kansai International Airport.



Osaka Bay, showing the location of the major coastal projects, the cities of Osaka and Kobe, and the area's transportation network. Insert shows major coastal cities of Japan.

sustain the highest significant waves that have occurred during the last 50 years – 3.5 meters, with a period of 6.7 seconds in a west-southwest direction.

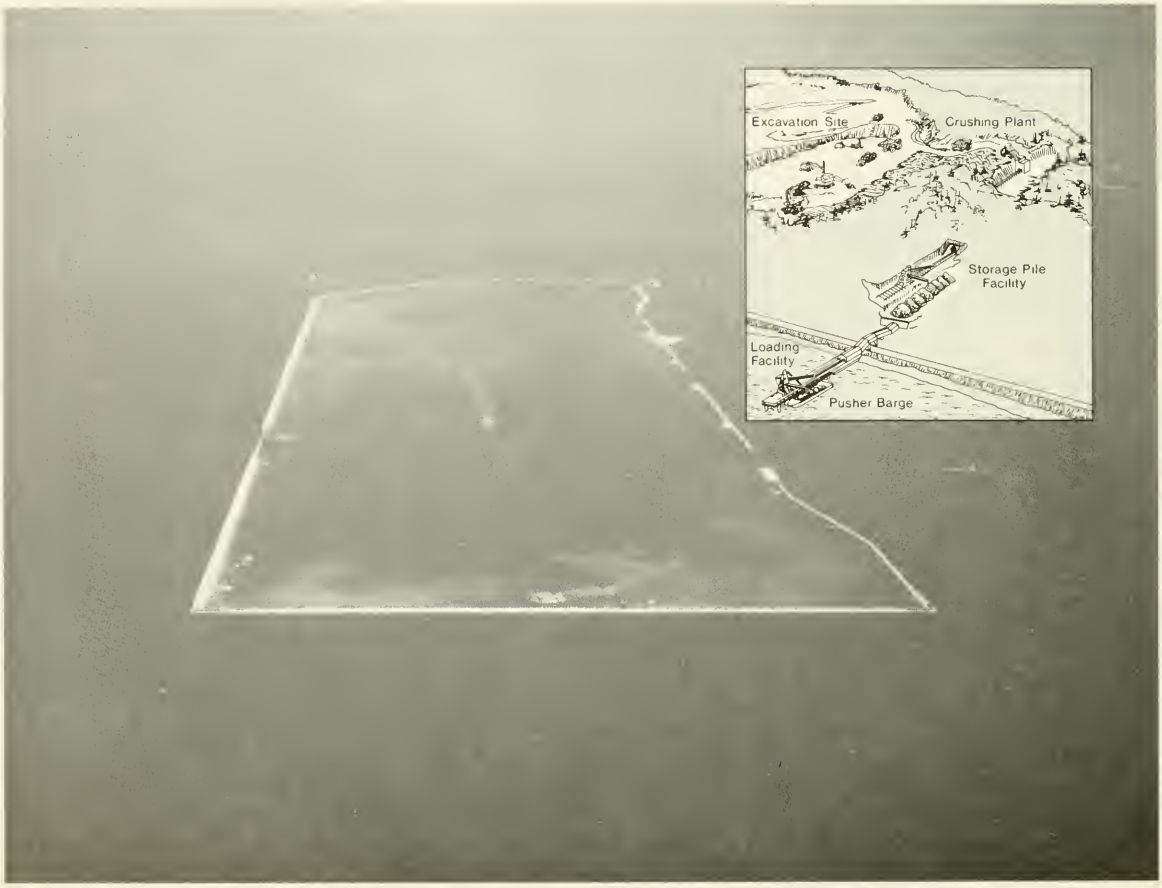
The plans for the island and airport went through a severe series of environmental impact assessments in 1985 and 1986. The airport will meet local environmental criteria in terms of noise, air, and water pollution, and marine animal and bird habitation. A long series of talks have been held with local fishermen over compensation for the loss of fisheries in the waters around and where the island is being built. Agreement was finally reached in mid-1986.

The Ports and Harbors Research Institute

Science and engineering support for projects like the Kansai International Airport comes from the Ports and Harbor Research Institute (PHRI), about 35 miles south of Tokyo in a suburb of Yokosuka on Tokyo Bay. There are only three major research institutes for port and harbor construction in the world – the other two being the largely civilian research facility of the U.S. Army Corps of Engineers at Vicksburg, Mississippi, and the Maritime Research Institute Netherlands in Wageningen, near Delft in the Netherlands.

Founded in April of 1962, PHRI conducts research on a wide variety of technologies relating to the construction of ocean and offshore structures, and maintenance of navigation channels.

The waters around Japan can get very rough. Consequently, the characteristics of waves is one of the most important subjects studied at



Completed seawalls of Kansai International Airport island (as of April 1989). Insert shows excavation operation.

the institute. And many ports are constructed on soft ground where earthquakes occur frequently. Port structures of great size and strength are often required. The institute is thus engaged in geotechnical and earthquake engineering. While touring PHRI, this author endured a simulated underwater earthquake of 8.6 on the Richter scale.

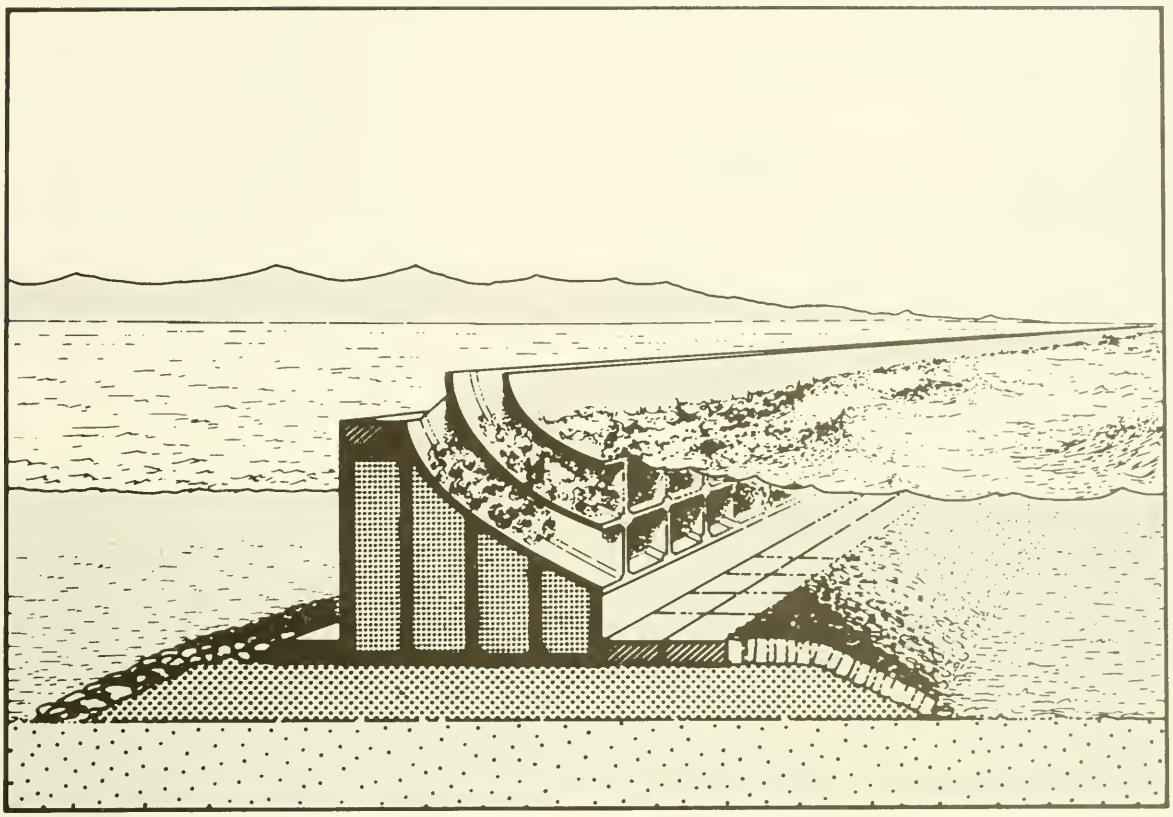
The institute has a staff of 201, of which 151 are engaged in research. The budget for 1989 was 1.58 billion yen ($11.3 million). In addition, 1.4 billion yen ($10 million) is earmarked for research connected with actual port construction projects under way, such as those in Osaka.

In conjunction with the Japan International Cooperation Agency, a quasi-governmental organization, the institute offers a training course in port and harbor engineering to people in developing countries worldwide. More than 500 trainees have participated in this course to date. In addition, staff members at the institute participate as consultants in studies for planned ports in other countries.

In addition to the considerable research on the properties of waves and currents, the institute is also concerned with the latest ideas in breakwater development. The most common type of breakwater around the world is the rubble-mound breakwater. Mixed-type breakwaters that consist of a rubble-mound foundation and an upright section are very popular in Japan.

PHRI has developed two new kinds of caisson-type breakwaters in the last few years. One is called a curve-slit caisson, the other a multicellular caisson. In addition, the Japanese scientists are exploring the possibility of extracting energy from these new types of

Curved-slit caisson in Funakawa Port.



An artist's impression of the multicellular caisson.

breakwaters. A prototype test caisson with a wave power to electricity convertor is scheduled to be installed this year in the port of Sakata for field tests. It is thought that these wave power breakwaters can produce enough electricity to run a lighthouse year in and year out.

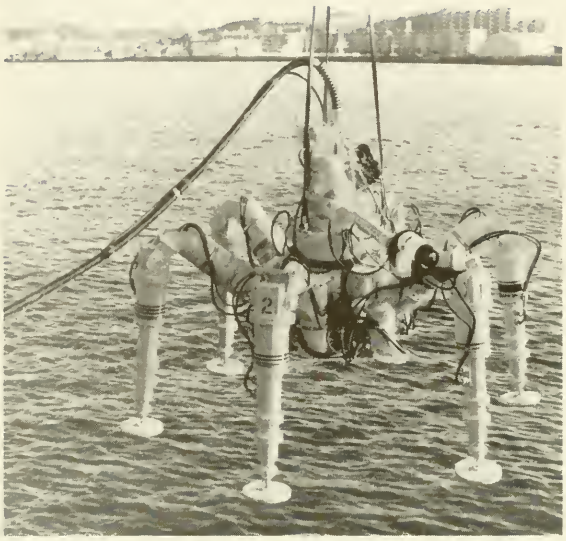
Another example of the type of research conducted at PHRI is a machine known as the Geotechnical Centrifuge, which is a huge spinning device used to create materials that will harden soft, clayey seabeds. In what is called the Deep Mixing Method, in situ soft soil is mixed with a cement milk and then run through the geotechnical centrifuge which can be accelerated to a force of 100 Gs, thus simulating underwater construction stress factors on the seabed.

Institute engineers are presently engaged in research projects having to do with offshore floating structures, such as oil storage systems, a coal center, an offshore city, a floating pier, and a floating breakwater. The planning and design of these floating moored structures require both field tests and model laboratory experiments. The institute has a number of large-scale tanks where model experiments can be conducted with wave, current, and wind simulators.

The trend in Japan as elsewhere is to construct port facilities in deeper and deeper water. In the past, most underwater survey work has been undertaken by divers. However, the move to deeper water has increased the risks for divers and lowered their working efficiency. To this end, PHRI has developed a six-legged Aquarobot that can crawl across the bottom like a large insect. It can walk in any direction and turn in its own space. All the motions of this tactile, tubular creature are controlled by computer. It can work in depths of up to 50 meters, over extremely rocky and uneven terrain.

The institute also concerns itself with the overall design of ports and harbors, the automatization necessary, the finances of a port, the cargo flow, questions of economics, and the behavior of ships, to mention but a few of the topics related to ports and harbor development.

The Geotechnical Centrifuge at the Ports and Harbors Research Institute, Yokosuka, Japan.



The Aquarobot.

The Restoration of Tokyo Bay

One of the largest maritime projects facing the government of Japan is the restoration of Tokyo Bay, a body of water with six major ports and ship traffic so dense that 50 vessels pass through the mouth in any given hour. At present, 26 different waterfront development projects are in the works that will have a critical environmental impact on this gateway to and from East Asia.

An overall concept for the restoration of Tokyo Bay is presently being developed by the Research Institute for Ocean Economics and the Oversea Coastal Area Development Institute, both headquartered in Tokyo.

Tokyo Bay is situated in the central part of Honshu, the Japanese main island, and faces on the Pacific Ocean. The bay extends for about 50 kilometers from north to south and 15 to 20 kilometers across, narrowing to seven kilometers at one point. Almost 90 percent of the bay coastline has been artifically created and about 20 percent is accessible to the public. In the central part of the bay, depths are generally between 40 and 50 meters, with 18 meters the average depth. The six main ports are Tokyo, Yokohama, Yokosuka, Kawasaki, Chiba, and Kisarazu.

The problems thus are enormous. Pollution must be decreased, maritime traffic either reduced or better controlled, and waterfront development projects better coordinated. Planners face increasing demands for recreational use of the bay's space. The loss of tideland as the result of large-scale reclamation projects in the period from 1966 to 1975 is another problem that has come home to roost for the Japanese.

Restoration planners see the need for what they call "artificial tideland, seaweed forest, and shallow water" areas to cleanse the bay. These areas, plus increased sewage and waste disposal facilities, are considered cornerstones of the restoration plan, contributing to all the waterfront development projects.

One of the newest development projects is the Tokyo Bay Crossing Way. This cross-bay bridge and tunnel project includes the construction of two man-made islands, one in Kawasaki waters and the other in Kisarazu. Bridges will connect the islands with the ports and an underground tunnel will link the central part of the way with the bridges. The Crossing Way is part of a broader coastal development plan that envisions communications, recreational, business, and tourist facilities on the artificial islands with links to the coastal ports.

The 26 waterfront development projects presently under way and others in the planning stage could bring another 820,000 people to what is already one of the most crowded population centers in the world—one that lives with the constant threat of a major earthquake. The addition of this many people in the area will tax water supplies and add to sewage volume. But Japan is moving the world with its industriousness. Restoring a couple of bays to zen-quality level should just be a matter of some serious meditation on the type of life required by the forces of the 21st century. □

Acknowlegements

This article was prepared from material supplied by Susumu Maeda, Managing Director, and Akira Komatsu, Manager of the Design Division of the Kansai International Airport Co., Ltd.; Shin Sasaki, Director-General of the Ports and Harbor Bureau of the City of Osaka; Hajime Tsuchida, Director, and Yasufumi Umehara, Deputy Director, of the Ports and Harbor Research Institute, Yokosuka; and Tamotsu Okabe, President of the Oversea Coastal Area Development Institute and Chairman of the committee on Tokyo Bay Restoration Project, and Hiroyuki Nakahara, Secretary-General of the Research Institute for Ocean Economics.

A view of Tokyo Bay from the Port of Yokohama

Stevedores at work, Puerto Quetzal, Guatemala.
(Courtesy of Inter-American Development Bank)

Puerto Quetzal, Guatemala: Container Cranes or Stevedores?

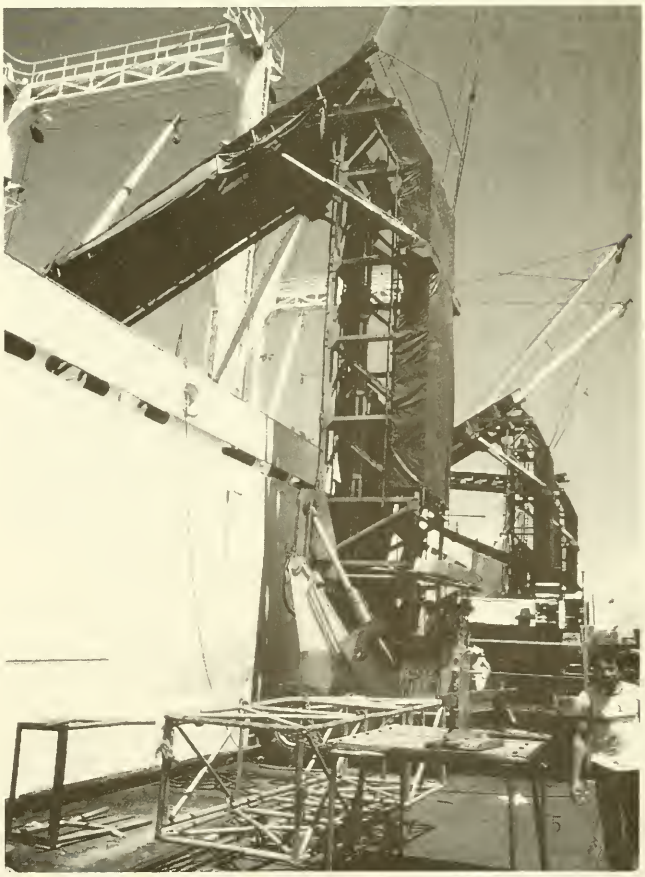
by Amy Friedheim

In March 1983, a new port on Guatemala's Pacific coast, Puerto Quetzal, was declared open and ready for operation. The long concrete wharf offered an open view of the blue Pacific, unencumbered by much of anything—few ships, no cranes, no buildings, no boxes, and very little activity. Unfortunately, the situation is much the same today, and more unfortunate still is that many of Quetzal's problems are typical of Third World ports.

Guatemala was then, and still is, faced with the familiar problem of how to make the most of its scarce capital resources. The government must choose between developing its ports, or developing other projects that are also sorely needed; and it must also decide on the balance of capital-intensive and labor-intensive means used to effect the developments. Guatemala spent $100 million on Puerto Quetzal, but ran out of funds before it could complete the project. Now, years later, the Guatemalans must decide whether to finish this project, reconstruct their Caribbean coast ports, or postpone action on their numerous port problems altogether.

Guatemala is a small Central American country with a population of 8.5 million people. Despite an abundance of natural resources, it is a poor nation with an annual income of $1,155 per person. The economy relies heavily on trade with the outside world, and most of it is waterborne. In 1987, Guatemala produced $9.6 billion worth of goods and services. In the same year, the country conducted $2 billion worth of imports and exports, more than 20 percent of its total production.

Critical Guatemalan imports include wheat, fertilizers, motor vehicles and accessories, and petroleum products. Like many countries in the Third World, the Guatemalan economy exports primary commodities such as coffee, fruit, vegetables, sugar, and petroleum, whose prices fluctuate in unstable markets. The value of many of these commodities has deteriorated markedly in the last decade, and as these values have declined, so has the financial health of economies tied to them. Guatemala, like many Third World countries, is experiencing serious economic difficulties. In 1987, it had a $104 million deficit of trade in goods and services. This economic pinch makes social choices, of which port development is a part, even more difficult than they would be otherwise.



Amy Friedheim is an economist in the Office of Transportation of the U.S. Department of Agriculture, Washington, DC.

The main port in the country is Santo Tomás de Castilla. Located on the lush tropical Caribbean coast, 307 kilometers from the nation's capital, Guatemala City, Santo Tomás handles about 80 percent of Guatemala's port traffic. There are numerous cranes, warehouses, pipelines, and railroad tracks. Off-port sites feature storage tanks, more warehouses, and a free-trade zone. There is little room for expansion on the immediate premises, and its frequent crowding forces ships and trains to remain idle until dock space or warehousing becomes available.

Puerto Quetzal is only 67 kilometers from the capital, and despite the more than $100 million already invested by the government to develop the port, it is currently operating at only about 25 percent of its potential capacity. Quetzal's growth potential is limited without additional handling equipment and related facilities. To complete the port, an estimated $20 million would be needed to purchase dry bulk handling equipment including troughs, hoppers, conveyors, and grain elevators; liquid bulk handling facilities including tanks, pipes, and pumps; and container cranes.

Modernizing Important Export Operations

A look at possible modernization of sugar export operations shows some of the port development problems in Guatemala. Sugar production is a major source of employment and revenue in the Guatemalan economy. Nearly 12 percent of the population works in the fields and processing plants during harvesting season. The 400,000 tonnes of sugar exported in 1986 represented five percent of all export revenues, and nearly 60 percent of the export traffic at Puerto Quetzal that year. However, sugar, like many agricultural commodities, is a fragile source of income. In 1986, the world price of sugar declined to 20 percent of its 1980 market value (from 29.02 to 6.05 cents per pound).

The world sugar market is very volatile. A small increase in the price of sugar can cause consumers to drastically reduce their purchases, either because they have found less expensive sources elsewhere, or because they have substituted some other sweetener, such as high-fructose corn syrup, for sugar. Anything—and this includes outdated port handling facilities—that adds even a fraction of a cent per pound to the price of exported sugar can cost Guatemala these markets.

Despite the importance of sugar to the economy, and the sensitive nature of the international market, Guatemalan sugar is handled by inefficient means. It is bagged at production sites, transported to the port by truck, hauled alongside the vessel, hoisted on deck by ship's gear, opened by hand, and dumped into the ship's hold. This extremely time-consuming process can require a ship to sit quayside for as long as 15 days. A mechanized loading process might shorten the dockside time to as little as one day.

The cost of ship maintenance in port is almost as expensive as that at sea. Consequently, any loading procedure that adds time to the movement of any export, particularly one as price-sensitive as sugar, can add considerable, even prohibitive, expense to the cost of the export. Even so, there is resistance to mechanization in some sectors for fear of stevedore unemployment. There is a clear need to improve port facilities, but what is not so clear is which port to improve, which improvements to make, when they should be made, and who will finance and control the facilities.

Obstacles to Mechanization

Each port offers its own set of logistical advantages. Today's trading patterns, dominated by traffic with the U.S. Gulf Coast ports, favor the expansion or renovation of Santo Tomás de Castilla. But there is very little land near the port on which to expand. Completing Puerto Quetzal, on the other hand, would in effect "open" trade with Pacific partners. Furthermore, most of the productive resources, including the population, are located in the western region of Guatemala, and shorter inland transportation routes—which are mile-for-mile far more expensive than ocean transportation—are shorter. In the long run, completion of Puerto Quetzal is the better investment.

Despite the clear national need for improved port capabilities, the Guatemalan government is unwilling or unable to finance any further investments in Puerto Quetzal. It is encouraging the private sector to do so. Guatemalan importers and exporters are considering investments in port facilities to maintain or improve their own businesses. Their main concern is how the new facilities would affect the profitability of their businesses. Presently, the congestion at Santo Tomás often results in penalties for keeping chartered ships in port longer than the contracted time. This adds to the costs of private businessmen, because

government ships have queuing preference at the docks. However, the cost of financing private port equipment is currently prohibitive. Many of the facilities or components would have to be obtained abroad, and interest charges can add 20 percent to the quoted prices.

Other factors deter improvements. Although the government expects the private sector to make these investments, it is not willing to relinquish any control of the facilities; and yet the considerable instability of Guatemalan politics and economics makes the risk of losing investment money very high.

The Guatemalan government has no clearly defined "port strategy" and does not plan to make further improvements in port handling equipment. It is, however, generally export-oriented and promotes public-private cooperation to increase exports and economic growth. It is also considering legislation to increase investment in Guatemala through the creation of free-trade zones and export incentives such as tax holidays.

The Role of the World Bank

The Guatemalan government is not alone in its lack of attention to, and long-term planning for, port development. The World Bank is a major source of funding for large-scale infrastructure developments such as roads, quays, electricity, education, and so on. The bank funded 170 port projects of one sort or another between 1980 and 1986.

Lending decisions used to be made on an ad hoc, project-by-project basis; and until recently, the World Bank did not address many of the social implications of port development in the Third World, nor did it consistently assess international market conditions. Now the bank requires more complete appraisals of potential projects. A port must assess its internal resources, such as available services, facilities, managers, and operational personnel. In addition, a port must consider factors beyond its control, like primary demand for commodities, the competitors for those commodities, the strength of competing ports, shifting trade patterns, and changing technologies.

Because of increasing labor costs and the slow pace of breakbulk* operations, there has been a worldwide trend toward capital-intensive port equipment—specifically, containerization. Almost 70 percent of all international cargo is now containerized. As this relatively new technology saturates the industrialized countries, many developing countries also are beginning to adopt these methods. Between 1980 and 1986, containerization featured in 15 of 34 Third World port projects financed by the World Bank, and 18 of the 34 explicitly addressed trade development. The recurring message is that if developing countries want to continue trading with the industrialized world, their chances of success increase with the ease with which they can fit into world trading patterns and technology.

An American grain ship lashed to docks. (All photos by author, except as noted)

A partially assembled liquid bulk trough.

A container ship at Santo Tomás de Castilla.

* Breakbulk cargo is made up of uneven packages that travel in the hold or on the deck of a ship; compared with containerized cargo it requires more labor.

More Modernization Not Always Better

That is not to say that modern technology will always benefit a country. The development of arterial river transport systems in Bangladesh is a good case in point. The government of Bangladesh has established a set of policies and priorities that favor the adoption of mechanized boats over traditional "country boats." Country boats are made from local materials and built with local labor. They are often crewed by owner-operators and landless peasants who spend their pay in rural areas, and therefore tend to stimulate the local economies. Conversely, mechanized boats are built of foreign materials, and run with fuels and expertise purchased abroad—a clear drain on the nation's scarce hard currency. Mechanized boats are most often owned by wealthy city-dwelling businessmen. The government encourages the adoption of mechanized boats by dredging inland rivers, offering lower freight insurance rates for cargo carried by mechanized boats than for cargo carried in country boats, and granting mechanized boats queuing preference at docks. Country boats must wait for access to the docks, and they are not compensated for the time they spend waiting.

The shift toward the use of mechanized vessels has lowered transportation costs, reduced transport times, improved the condition of goods on arrival, and increased the reliability of shipments. The producers and consumers of these goods, many of whom are wealthy city-dwellers, benefit from these innovations. But country boat operators have lost jobs, and those who can still ply the trades have lost income, since the freight rates have declined. This has had an adverse impact on the rural economy.

There is, however, a fundamental difference between the Guatemalan and the Bangladeshi situations. The latter is a case of the transfer of wealth from the poor to the rich within Bangladesh, with no prospect of increasing national income. On the other hand, Guatemala's situation is directly linked to national wealth. Without change, Guatemalan participation in world markets could be threatened either because local practices might price their export commodities out of the fiercely competitive world market, or because their trading practices simply do not mesh with prevailing technologies.

Market Ultimately Decides Profitability of Ports

If mechanized loading operations for sugar were installed, there is of course no guarantee of improved trade; given declining world prices and increased world competition, the new facilities might only maintain the current level of sugar operations. But if trade did improve, benefits would go to the owners of the new facilities, and perhaps, to some of the employees of the sugar production and refining operations. This scenario would occur at the expense of the stevedores, but it would also create new jobs, as containers would be filled inland. Is it better to save the stevedore jobs in the short run, possibly at the expense of Guatemala's future access to the world sugar market; or to save the sugar production and refining jobs, and some of the sugar bagging jobs? International trade is a dynamic environment, and in order to participate, countries must face the prospect of change and competition, neither of which comes without both winners and losers.

To date, two new bulk cranes and several warehouses have been installed at Puerto Quetzal, all financed with foreign aid. One tallow importing company has begun to build an installation there, but little else has happened since the port began operating in 1983. Location and ownership issues for a number of commodities have not been resolved, nor the financing considered, and the set of contentious issues involving appropriate technology and the sugar industry are still a problem. As is the case in many port development situations, there are many problems yet to be explicitly addressed, let alone in a timely fashion.

The bottom line is that there is no formula that can automatically determine the best course for a particular country or port project. Rather, each country should set long-term national goals, and within that context, evaluate port development on a project-by-project basis. □

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LA and Long Beach

A Tale of Two Ports With "2020" Vision

by James A. Fawcett

In 1857, when Phineas T. Banning first envisioned a seaport in California's San Pedro Bay at Rattlesnake Island, he could not have imagined in his wildest dreams that one day two of the largest, most active seaports in the world would occupy that site. In the 132 years that have passed since Banning's vision, the independent ports of

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Liquid bulk carriers pass each other in the main channel of the Port of Los Angeles.

This lot in the Port of Los Angeles holds 5,000 newly imported cars and light trucks when full.

San Pedro Bay, 1987, facing north. The Port of Long Beach is to the right of the photo and the Port of Los Angeles to the left. Terminal Island is in the center of the harbor and the hook-like projection below Terminal Island is the Navy Mole Pier, a part of the Long Beach Naval Station. (Courtesy of the Port of Los Angeles)

Long Beach and Los Angeles have emerged from what was once a coastal wetland and an elongated sand spit into major powerhouses of marine transportation. Even as they set new records for U.S. cargo handling, they are preparing for a massive new round of port expansion. The two ports intend to spend almost $4.8 billion to expand and upgrade their facilities by the year 2020, following a long-range planning effort called the "2020 Plan."

The ports sit side by side on the south end of the Los Angeles basin. One, the Port of Los Angeles (also known as "Worldport LA"), is within the city limits of San Pedro and Wilmington, incorporated communities of the City of Los Angeles. The port also occupies approximately half of what was originally Rattlesnake Island, now called Terminal Island. The Port of Long Beach is immediately east of the Port of Los Angeles, their border being the north-south midline of Terminal Island. The port also occupies the shoreline south of the center of the City of Long Beach.

Distinct Identities, a Combined Powerhouse

By casual appearance, they are one port, but nothing could be further from the truth. City images and reputations identify with each port, and political and marketing struggles have been fought over the years to add cargo tonnage to one port, often at the expense of the other. In 1987, the Port of Los Angeles was ninth, and the Port of Long Beach was tenth in the world in terms of handling containerized cargo.

Yet, if we were to compare these two ports to others, in terms of the *combined* tonnage of containerized cargo, Los Angeles-Long Beach would be the second busiest port complex in the world, just behind Hong Kong and ahead of Rotterdam in the Netherlands (article, pp. 59–65) and Kaohsiung in Taiwan. In comparison to other U.S. ports, the combined ports of Los Angeles and Long Beach handled fully 50 percent more containerized cargo in 1987 than their nearest competitor, the Port Authority of New York and New Jersey.

Why has southern California generated such growth in marine transportation? Is it likely to continue? The most important factor for locating a port at Los Angeles has always been the ease of rail transportation to the east. Certainly, San Francisco has a great natural harbor with adequate room for multiple ports within the bay, but its rail links with the east are constrained by the Sierra Nevada Mountains. The Southern California ports experience consistently

The World's Busiest Container Ports

Port	1987 Cargo in TEUs	Country
Hong Kong	3,457,182	Hong Kong
Rotterdam	2,813,395	The Netherlands
Kaohsiung	2,778,786	Taiwan
Singapore	2,634,500	Singapore
New York-New Jersey	2,089,421	USA
Pusan	1,949,143	South Korea
Keelung	1,939,854	Taiwan
Kobe	1,877,459	Japan
Los Angeles	1,579,657	USA
Long Beach	1,460,287	USA

Source: *Containerization Yearbook, 1989.*

better rail performance because of better weather and less-mountainous rail routes.

Notwithstanding the advantage held by southern rail routes, the population and industrial power of the metropolitan area further enhance the position of the two ports. First, carriers seek to offload the bulk of their cargo at major "load centers" if at all possible; Southern California is such a load center. Second, the population and industrial size of the area makes it likely that railroads and trucks will carry loaded containers in both directions (that is, both outbound from Los Angeles and as backhaul cargo from the hinterland). Another major reason for the present success of Southern California ports is the influence of Pacific rim trade on the overall movement of goods throughout the world; in 1987, eight of the top ten container ports in the world were on the Pacific. Pacific trade is growing rapidly, and is expected to do so well into the 21st century. The ports of Los Angeles and Long Beach believe that the only way they can reap the benefits of this burgeoning trade is through long-term facilities upgrading and expansion.

The 2020 Plan was developed by the two ports in cooperation with the U.S. Army Corps of Engineers. It is a phased program of dredging, reclamation, and construction that will culminate in the world's largest integrated marine-highway-railway transportation hub.

A Preferred Version of the Plan

The plan offers two alternatives. The preferred, less expensive "Alternative B" will add 2,400 new acres of landfill and 600 acres of development on existing land. Thirty-eight terminals will be added to today's 70 (Tables 1 and 2). Seven miles of deep-draft ship channels and many other facilities will improve the transport of cargo into and out of the ports.

Planners at both ports agree that cargo demand will grow considerably over the next 35 years in this metropolitan area of some 14 million people. A recent study estimated that the largest growth will be in containerized cargo, with somewhat slower growth in neo-bulk (uncontainerized) cargoes and automobiles. Even using a modest compounded annual growth rate of 3.1 percent, such growth would justify the cost of all of the envisioned facilities.

A number of radical changes will take place as the ports implement the 2020 Plan. Physically, new berths will handle much larger ships than those currently accomodated at either port. But for the plan to be politically acceptable, the ports must demonstrate that its implementation will lead to less air pollution and traffic congestion.

To tenants and port officials alike, at least one of the major changes will be the introduction of so-called "on-dock rail" or "near-dock

Table 1. Existing terminals at the Ports of Los Angeles and Long Beach.

Terminal Type	Port of Los Angeles	Port of Long Beach	Total
Container	8	7	15
General Cargo	11	12	23
Dry Bulk	4	5	9
Liquid Bulk	14	9	23
TOTAL	37	33	70

Source: *2020 OFI Study Summary*, Ports of Los Angeles and Long Beach, 1988.

Table 2. Proposed new terminals at the Ports of Los Angeles and Long Beach, by the year 2020.

Terminal Type	Port of Los Angeles	Port of Long Beach	Total
Container	5	6	11
Neo-Bulk and Auto	9	8	17
Dry Bulk	1	3	4
Liquid Bulk	5	1	6
TOTAL	20	18	38

Source: *2020 OFI Study Summary*, Ports of Los Angeles and Long Beach, 1988.

"Alternative B," with the two phases of landfill. Hatched area is Phase One and white area is Phase Two.

rail." On-dock rail poses very little, if any, technical challenge to engineers. Redesigning and retrofitting existing facilities, however, is a huge task. Nevertheless, moving container transfer operations nearer to marine terminals solves two problems: first, it reduces the cost of truck trips in and around the port; and second, the shorter truck trips cause less air pollution. The benefits of cleaner air accrue to a greater degree when we consider the reduced overall traffic congestion in the port area.

Another innovation of the 2020 Plan will be the dedication of a major north-south arterial highway, Alameda Street, into a rail-truck-utility transportation corridor. Alameda Street terminates near the ports, and connects major industrial areas with the ports as it runs for 35 miles to the north. By upgrading the transportation corridor, the ports can reduce one of the major sources of congestion, citizen complaint, and pollution. Presently, truck traffic enters and leaves the ports via two freeways—the Long Beach Freeway into the Port of Long Beach, and the Harbor Freeway into the Port of Los Angeles. With the construction of the Alameda Transportation Corridor, general-use freeways and arterial highways will be relieved of a considerable amount of short-haul and intermodal* rail traffic. The corridor also will support utility lines required by harbor operations.

Plan Requires United Effort

A "joint powers authority" is presently being formed by representatives of the two ports, eight neighboring cities, the Southern California Association of Governments, and the Los Angeles County Transportation Commission to supervise the planning and implementation of the corridor, and solicit funds for the project. The ports do not have a majority on the board and will have to negotiate their transportation requirements with their neighbor cities. Regardless of the difficulties inherent in managing a joint powers authority, the ports have little choice in the matter, since they need the goodwill of adjacent cities to legitimize and facilitate their expansion. Many believe that implementation of the corridor is essential to the viability of the 2020 Plan.

The final outcome of the 2020 Plan is, of course, very conditional. For the designers of the facilities, the project becomes a reality when it is completed as designed, but for others the 2020 Plan is far less a blueprint than a process through which the two ports become better linked to their surroundings. But if none of the proposed facilities actually come to reality, despite the 35

*The term "intermodal" refers to the marine-rail-truck transportation system that transfers cargo quickly and easily between transportation modes without unpacking and repacking the cargo.

Coal from Utah is transported by rail to both ports and often shipped to Asia.

As in many other ports, fishing, petroleum and chemical storage, and recreation are close neighbors in Southern California ports.

years of discourse between the ports and their neighbors, shall we then consider that the plan was never implemented? I think not.

Undoubtedly, designs conceived in 1989 will be reworked and revised along the way. An increase in the price of oil may make coal terminals more attractive than they now are, for example, or a change in exchange rates may dictate that future trade does not live up to present expectations. As we consider the 2020 Plan today, there are several major problems facing implementation of the project.

For most observers, the critical question is whether there will be sufficient demand to justify the construction of the planned facilities. Economists' assurances aside, the complexity of the international market makes the building of a good predictive model difficult in the extreme. The ports have had very sophisticated assistance in developing cargo forecasts, and that assistance will continue. But the wisdom of such large capital expenditures hinges to a great extent on the ability of the ports and their economic consultants to update the model, modify its parameters as needed, and validate its projections.

An environmental concern is that the air quality in the area is already below federal clean-air standards. Air pollution is likely to seriously reduce the ability of the two ports to expand unless they can 1) demonstrate effective methods for reducing emissions; 2) demonstrate that any environmental costs of additional air pollution are offset by social benefits; and 3) convince a heretofore passive public that the benefits of port expansion are so vital to the local economy that some version of the plan should be implemented.

These are but two of the questions that confront the ports of Long Beach and Los Angeles as they contemplate the largest single improvement project in their history. But the essential challenge is not technical. It is rather to engage in long-term discourse with a public increasingly wary of environmental risks, and to assure them that the development of this mammoth project will not jeopardize their health and prosperity, but in fact will improve the quality of their lives. □

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Naval Bases, Base Rights, and Port Access

by Joseph R. Morgan

In a world of changing naval strategies and shifting political relationships, it is still important for navies to maintain their options for port calls.

Ports are primarily facilities that load and off-load cargoes. Almost all sizeable ports also serve the important secondary purpose of enabling ships to obtain food, water, fuel, general supplies, and necessary repairs. For naval vessels, the primary *raison d'être* of a port is far less important than its secondary functions; and a specialized category of ports, the naval base, has been established by virtually all countries to support their naval fleets.

Large naval bases in the United States are small cities, sometimes providing employment for thousands of civilian workers as well as varied facilities for naval personnel and their dependents. These may include commissaries, navy exchanges—often comparable to small department stores—gymnasiums, baseball fields, barracks, family housing, schools, churches, golf courses, swimming pools, and extensive repair facilities in the form of naval shipyards. Naval bases in other developed countries are often equally well endowed.

The United States maintains naval bases overseas, the most newsworthy one being Subic Bay, in the Philippines. The naval base at Subic Bay is notable principally for the potential problems it poses. The renewal of rights to maintain the base has been a recurring problem for the United States, as the government of the Philippines periodically examines both the desirability of a large military

26 September 1988. As some 40 U.S. warships attempted to enter Sydney Harbor, the Australian Peace Movement came out in force to demonstrate in an antinuclear action. (Courtesy of Greenpeace)

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installation on its soil, and the price that the United States should be expected to pay for the privilege of maintaining facilities there.

Ally and Enemy Problems

An important naval base on foreign soil may become a problem for the host country. It is evidence of a de facto military alliance between the two countries, and in a world where superpower rivalry is still dominant in security considerations, an enemy is inevitably made. States that want to remain unaligned or neutral obviously cannot afford to risk the consequences of foreign military bases in their country.

Naval powers that maintain large overseas bases are usually capable of employing nuclear weapons. Hence, ships at the bases are liable to be nuclear armed, and it is possible that nuclear weapons are stored at the ammunition depots frequently associated with naval bases. Some countries feel that the presence of nuclear weapons on their soil is undesirable for a number of reasons: they may become prime targets for a nuclear-armed superpower, there may be a natural abhorrence to anything nuclear among the majority of the citizens of the nation, or there may be a widespread fear that nuclear material risks serious accidents that will have grave environmental consequences.

Finally, there are a number of political and social effects associated with foreign naval bases. There are problems with law enforcement among citizens of a foreign country, and the proximity of large numbers of naval personnel often attracts prostitutes, bars, and other establishments considered undesirable by some. Agreements establishing naval bases on foreign soil need to consider factors such as criminal jurisdiction, command relationships, prohibited activities and practices, relations with the nearby civilian population, and community affairs in general.

In a world that is becoming increasingly multipolar, both the Soviet Union and the United States have troubles maintaining bases in the territory of several of their former strong allies. Many countries no longer feel it desirable to ally themselves completely with one or the other superpower, and permitting a large naval base on their soil seems to them to be disadvantageous. It reduces flexibility in making important security decisions.

There is an obvious quid pro quo, however, since naval bases provide employment, foreign exchange, a boost to the local economy due to the presence of foreign naval personnel, and the substantial lease or rent payments usually involved in maintaining the base on sometimes-expensive real estate.

In the last decade, the Indian Ocean has increased in strategic significance to both the United States and the Soviet Union. The Soviets have had mixed success in maintaining base facilities in a number of East African countries, and they have been forced to make frequent changes as one nation after another has either had a falling-out with the Soviets, or decided to embrace them as allies.

The United States now seems secure at Diego Garcia, an island in the British Indian Ocean Territory. Extensive facilities for large ships and aircraft have been established, and operations in the western Indian Ocean and Persian Gulf can be supported from this central Indian Ocean location. In addition, the American Rapid Deployment Force is now based at Masirah Island, Oman. This force includes prepositioned and preloaded support ships for a possible landing of troops in a trouble spot. The Rapid Deployment Force ships can be supported by less extensive facilities than are normally found in a full-fledged naval base.

Options to Foreign Naval Bases

It is not always necessary or even desirable to maintain overseas naval bases with their many facilities; under some circumstances lesser types of fleet support installations will do just as well. *Base rights*, in which a foreign navy has the right to use a port with relative frequency—including even having preassigned piers or anchorages for its ships—may be all that is needed to support naval operations in a region. There are obvious advantages to this type of fleet support. There need not be expensive investment in buildings and dockside facilities such as cranes and warehouses, and there is less of a problem with command arrangements and other legal matters.

The disadvantages of base rights compared to established overseas naval bases are that the former cannot provide complete support; it is usually not possible to carry out major repairs to ships or to load ammunition. The ships must be more or less self-sufficient, needing only periodic replenishment of fuel, food, and general supplies. Where base rights are granted, there often will be a small group of personnel to maintain liaison with the foreign country and to assist the commanding officers of the naval vessels in obtaining the support they require. But there need not be large numbers of naval personnel, and hence there is a smaller chance that legal problems will arise.

In a hierarchy of support for naval vessels, the third category is simply a more-or-less guaranteed permission by friendly nations for foreign naval ships to make *port visits*. Since in the case of navy ships there is no commercial trade involved, there is per se no reason why a country must allow naval vessels to enter its ports. Permission is granted on the basis of good will; implied or actual alliances; and reciprocal arrangements for

countries with large navies.

In peacetime, visits by naval vessels to foreign ports are for crew recreation, refueling, obtaining general supplies, and expressions of friendship between the two countries. The visiting ship will often schedule an "open house" so that interested local residents can see a foreign navy ship and meet some of its crewmembers. Sailors may participate in local events or holiday celebrations, if appropriate; they may march in a parade, for instance. Commanding officers of visiting ships are concerned that their crews be well dressed, well behaved, and, in general, create a good impression on the local residents. They are likewise concerned that the ship itself creates a good appearance; spit and polish is the order of the day.

A helicopter lands on the USS Midway *in Tokyo Bay. (Photo ©Lon E. Lauber)*

Showing Guns and Flags

Port visits may be for the purpose of "showing the flag," that is, demonstrating that the visiting navy is interested in the country and the region, is capable of performing its missions, and is a true friend of the country visited. Showing the flag is not the same as "gunboat diplomacy," however. The latter implies some degree of threat or deterrent function, and is normally carried out for some very specific purpose such as preventing a conflict or protecting the rights of a nation's citizens in a foreign country.

A battle group, consisting of an aircraft carrier or battleship and its associated support vessels, frequently serves as the "gunboats" in modern blue-water navies. A simple port visit, on the other hand, can involve a single ship of quite modest size and armament. A port visit is made with permission. A display of gunboat diplomacy usually does not involve entry into a foreign port, and permission is not needed since the ships will presumably remain outside the claimed territorial waters of the country. Both showing the flag and gunboat diplomacy require visibility—hence surface ships rather than submarines are employed.

The Nuclear Issue

There are a number of reasons why some countries refuse permission to naval vessels of large powers to visit their ports. The visited country may want to preserve its neutral or nonaligned status, and it may fear that visits of foreign navy ships might imply an informal alliance. Since this is still a bipolar world, allowing U.S. ships to visit might incur the disapproval of the Soviet Union, and vice versa. Increasingly, however, the decision to refuse a port visit is based on the issue of nuclear weapons. If the visiting ship is not nuclear armed, permission may be granted; but if the vessel has nuclear weapons on board, the requested visit would be refused.

This policy provides a particular problem for the United States Navy, since its policy is to refuse to state whether any ship is nuclear armed. This well-known policy of neither confirming nor denying the presence of nuclear weapons on board a navy ship has invited some countries to routinely deny permission for port visits. The most notable example is New Zealand, which while technically still a member of ANZUS—a military alliance of Australia, New Zealand, and the United States—does not allow U.S. naval vessels to visit her ports. Since the U.S. Navy steadfastly refuses to confirm or deny the presence of nuclear weapons on its ships, the United States and New Zealand have reached an impasse, which neither side seems to be capable of breaking.

On the other hand, Japan too has an antinuclear policy, one which is much more understandable than New Zealand's, since Japan is the only country to have suffered the horrors of a nuclear attack. Yet, Japan routinely allows U.S. Navy ships to visit its ports and permits U.S. naval bases on its soil. Japan takes the view that U.S. ships can be assumed to be free of nuclear weapons if the U.S. does not confirm the opposite; New Zealand takes the contrary view, assuming nuclear armament unless the U.S. denies it.

While there is undeniably a strong antinuclear movement in New Zealand, and domestic politics are without question important in New Zealand's policy, the differences between New Zealand and

Japanese policies might be explainable on the basis of strategic grounds. Japan and the United States have an agreement in which the United States will provide a "nuclear umbrella" for Japan, since Japan's post-World War II constitution forbids the maintenance of armed forces for other than strictly defensive purposes. In short, Japan needs the might of the United States.

The same may be said of New Zealand, however, since the New Zealand Navy is obviously too small and poorly armed to provide much protection for the country. But many, both in- and outside of New Zealand, believe that the United States cannot be counted on to provide the country with protection, if by doing so it risks nuclear war with the Soviet Union. The belief is that New Zealand is simply too far away, too remote, and not important enough to the United States. I have heard intelligent New Zealanders ask: Would the U.S. be willing to risk a nuclear attack on New York City to protect Auckland? In short, it is possible that New Zealand simply does not believe that the ANZUS alliance can be counted on to provide the country with much protection, and that they will be better off going it alone. They believe that the alliance with the United States makes them a target, and that their remoteness is their salvation.

A Possible Solution

The U.S. Navy recently announced that certain classes of nuclear weapons, specifically those short-range missiles carried on ships to provide antiaircraft and antiship protection, were being taken out of service.

That being the case, it can reasonably be assumed that small combatant ships—destroyers, frigates, and even some classes of cruisers—will no longer be nuclear armed. It seems reasonable for the United States to state that ships of various sizes and classes do not have nuclear weapons on board, thereby permitting the New Zealand government to permit port visits. New Zealand might still deny visits to aircraft carriers and battleships, since the U.S. Navy will presumably continue to employ the "neither confirm nor deny" policy. Admittedly, this is only a partial solution, but most problems are eventually solved by compromise on the part of both sides. The United States might well compromise on its nonadmission policy in the case of smaller ships, since it can now be reasonably concluded that these ships are not nuclear armed. New Zealand does not need to compromise at the present time, but might be inclined to do so in the future, if the United States takes the first step.

Port Visits: The Future?

While New Zealand's policy concerning port visits represents the views of other countries as well, particularly those of Pacific Island nations which have strong antinuclear feelings, there have been some recent developments that might lead one to conclude that the United States might gain access to more, rather than fewer, ports. The People's Republic of China invited U.S. Navy ships to visit Qingdao, the first such visit since the end of World War II; in return, a Chinese ship visited U.S. ports. Alliances change and countries that were once enemies become friends or allies. This has been particularly the case with the Soviet Union, which enjoyed friendly relations with a number of East African nations at various times. The Soviet Navy had access to ports that are now denied it, and has visiting rights in other ports that it did not have before.

Naval powers will undoubtedly find ways to operate their ships with less access to friendly ports. They already have considerable capability to do this in the form of "under way" replenishment of fuel, ammunition, food, and some general supplies. What they lack is shipyard and repair facilities, particularly drydocks, which require ports. If port access continues to be denied to the superpowers by many countries, we might expect the pace of naval operations to decrease; there will be less "show the flag" type cruises. But, when certain types of gunboat diplomacy are needed, the superpowers will undoubtedly find some way to respond. □

The Perils of Gentrification

Port Concept Often Adrift in Waterfront Revitalization

by Marc J. Hershman

The United States has hundreds of important port cities along its coastal and inland waterways. Yet the leaders and citizens of these port cities often know far more about their cities' urban attributes—the parks, neighborhoods, cultural centers, shopping areas, and downtown—than they do about the cities' maritime attributes. Herman Melville's words in the opening paragraphs of *Moby-Dick* are still true: "Thousands of mortal men and women [throughout the city are] fixed in ocean reveries [and discontented unless they] get just as nigh the water as they possibly can without falling in." But it is the rare citizen of a modern port city that can name the vessels that make port calls, list the types of goods traded, describe the

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The image of the waterfront as a social gathering place is enhanced by coverage in national magazines such as this one, but the port's crucial shipping activity often is relegated to the background.

fishing gear mounted on boats, or locate nearby fishing grounds or submarine features on charts and maps.

Some of the barriers to a broader awareness of a city's maritime heritage are physical—maritime areas are fenced off, and in many cities, highways or train tracks must be crossed to get to the waterfront. In some parts of the country, large bluffs separate the people zone from the marine zone.

Roger Revelle, the distinguished oceanographer (profile, *Oceanus* Vol. 25, No. 4, pp. 67–70), has said that a two-way "iron curtain" exists at the water's edge. People on land, looking out to sea do not comprehend the language, technology, and behavior of seafarers, and the surface of the water prevents people from seeing beneath it. In some harbors the density of activity, and the mix of industrial and recreational images, makes the area incomprehensible and thus poorly appreciated. Urban dwellers pass it rapidly, label it "port," and take it for granted. Another barrier to port city awareness is subtle but nonetheless powerful. The information and high-technology age has put many trade and maritime workers in downtown offices or warehouses far removed from the waterfront.

Places for People, Not Ships

One might offer that the waterfront revitalization movement in the United States is bringing people back to their maritime world. Hundreds of successful waterfront projects adorn the bays and rivers of our watery nation. They extend from Boston to San Diego, Charleston to Seattle, including large and small cities. But virtually all of these projects are "people places" where the fare offered up is entertainment, shopping, eating, and playing. These projects have done wonders by creating exciting urban recreation zones while rebuilding decayed waterfront structures. But they are part of the *urban* fabric of the city and have done little to advance port city consciousness.

Civic leaders should make the port city concept a tangible part of city affairs. It can bring a side of the urban community to light that is central to its economic affairs. It can reveal a history that—for many cities—explains present-day topography, place names, legends, and structures. It can prepare people for challenges in globalism, environmental restoration, ocean exploration, and economic competitiveness.

Port cities are economic development engines and the root of economic development. The nation is a grab bag filled with widely varying city economies. A city's exports allow it to purchase and ultimately replace imports, leading to expansion of its economy. The port functions of a city, including all modes of exchange in products, services, and information, is central to economic life.

The public port institution is a well-developed governmental mechanism poised to jump upon new economic development opportunities that could benefit a local economy. They are in the business of anticipating new opportunities, and spending their "patient money" on ventures that are not quite ripe enough for private investment. With a strong tradition of supporting port city development, they are the logical entity to promote and encourage an expansion of port city consciousness.

Symbiotic Possibilities

Port cities extend into global economic, cultural, and information networks. They depend on trading partners and competitors, on cultural exchange and relationships. They contain communities of people with common interests and shared experiences in the trade, transport, and maritime fields. Through these communities of workers, innovations and symbiotic relationships can take hold. These relationships need not be restricted to trade and transport, as Jan Morris points out:

> *It remains now, as it was in 1969, as it was indeed in 1669, above all a landing-stage, a conduit, a place of movement and its character is governed always by the successive tides of energy that flood perpetually through it. Not just fissile things, but peoples, ideas, philosophies—these are and always have been the prime commodities of the port of New York, and the city's* raison d'être.
>
> —*From* A Great Port: A Passage Through New York

Local government and port agencies can take advantage of these relationships to improve port city consciousness. They need not sit idly by and assume a powerless position. While it is true that world economic and technological trends determine much about growth and change, local attitudes and policies can make enormous differences in how trends are recognized, understood, and acted upon.

Local government policy regarding land use is a direct way to influence the port city. As transportation technologies and industrial patterns have changed, certain districts in port cities have been rebuilt with public and private funds to serve urban needs, such as recreation, housing, and tourism. This trend has been so successful that traditional maritime uses—those that support port city maritime functions including repair, provisioning, and cargo handling—are being displaced by the new urban uses.

> *Small boat building and repair yards [on Seattle's Lake Union and] in the district of Sausalito, California, are threatened by gentrification of the surrounding area; tugboats in Jersey City and lobster boats in Boston Harbor are being displaced; in Portland, Maine, the city struggles to maintain the fishing fleet and*

seafood processors on its downtown waterfront.
—Robert F. Goodwin
In Urban Ports and Harbor Management, *edited by Marc J. Hershman.*

Land use controls that protect maritime use are possible. Seattle, Washington, and Portland, Maine have adopted restrictive land use practices in certain designated "maritime zones," where the preference is clearly stated for uses that support maritime industry. Land banking by local government, whether it be general purpose governments or special districts such as port authorities, is a way to encourage marine business development.

The Amsterdam Example

Port city planning can be more attentive to maritime economic development. A historian, Josef Konvitz, studied port city planning in 17th-century Europe and found that city leaders in that day recognized the need for naval and commercial sea power, and planned cities accordingly.

Physical planning in Amsterdam, for example, expressed a new, affirmative reliance on sea power. A series of canals on the outskirts of the city allowed it to expand as it entered new phases of maritime development. The canals integrated the parts of the city into a whole and allowed progressive growth. The extended waterfront provided multiple opportunities for people to witness maritime activities daily. Waterways were a principal public arena for social life.

Konvitz reflects on today's conditions and notes that leaders in urban affairs, and elites concerned with maritime development, have little to do with one another. He sees the need for a more integrated approach to port city planning that will bring together the multiple needs of urban, environmental, and maritime development.

Modern port cities have a colorful maritime history. Along the revitalized waterfronts that hundreds of thousands of people visit regularly, stories of city waterfront history can be told through signage and programs. Historic preservation of vessels at waterfront sites can emphasize a port city's marine history as is done in New York City's South Street Seaport and San Diego's Embarcadero. Most waterfronts feature remnants of an earlier age such as finger piers and railroad spurs.

But port city education can look at today and at the future as well. Today's marine economy has its exotic dimension, its special vocabulary, its unique equipment. There are adventurers and risk takers along the water's edge who enliven the city and add to its rich texture. Exploration of the sea, the search for new products, and experiments with special technology can be the focus of attention and appreciation within the city. In effect, the idea of a port city can become a specific reality to people, and a source of pride. It can alter the atmosphere for investment, improve the attitude and training of workers, influence shoreline land-use decisions, and contribute to a strengthened marine economy. In Seattle, a contemporary maritime museum is under development that will display the present-day and future dimensions of shipping, trade, fisheries, ocean exploration, and harbors.

Investing In the Future

Finally, civic leaders can invest directly in port city advancement. Most port cities have a public port agency with a mission to promote economic growth through infrastructure development and marketing. Most public ports encourage cargo movement through the city on the assumption that more cargo movement stimulates jobs and the sales of goods and services.

Over the last two decades, enormous changes have occurred in transportation technology, industrial location, and the service industry. Public port agencies have changed in response by diversifying into such businesses as waste disposal, water-taxi service, whale watches, teleports, and convention centers.

The fundamental role of the public port remains, however, providing shore-based facilities for new or expanding uses, often in advance of the full development of that use. They do this to secure a competitive advantage over other port cities, and to seek private investment commitments. This is where port authorities can play a key role in fostering marine economic development. There are a number of examples of this strategy. Fishports have been built in Boston, New York, San Francisco, and Seattle in response to the Americanization of the offshore fishing fleets. These new facilities were designed to be home ports for the fishing industry, and to attract vessels, their suppliers, and customers to one location and achieve a symbiotic nest of businesses and services.

In New York, the port authority teamed up with other companies in a joint venture to build a teleport on Staten Island—a set of high-speed, high-volume satellite transmission dishes—in response to the problems of radio transmission interference in New York City. In some cities, ports are responding to traffic congestion problems by studying or implementing commuter ferry systems. In other cities, the huge growth in the cruise business has produced complexes designed to capture a range of cruise ships, tour boats, and their support businesses. □

letters

To the Editor:

Margaret Klinowska asserts that there is a poor correlation between brain size and complexity, and intelligence in mammals and concludes that this constitutes a good reason to doubt the existence of cetacean intelligence. ("How Brainy are Cetaceans?" *Oceanus*, Volume 32, Number 1, pp. 19–20)

Unlike John Lilly, most people interested in dolphin intelligence are not attracted by the dolphin's large brain. They are drawn by the dolphin's fascinating behavior, which goes far beyond the trick-learning ability of other animals. David Gaskin's conclusions likening wild dolphins to cattle notwithstanding, most are astounded by the complexity and interactiveness of dolphins.

It seems unlikely that cetaceans would have the same types of advanced brain structures as the higher primates after 50 million years of divergent evolution. If the cetacean brain is indeed primitive, then it certainly proves Klinowska's point that one cannot measure intelligence by brain anatomy. We might give the cetaceans the benefit of the doubt, however, when comparing their relatively unstudied brains to the most extensively mapped brains in the world, those of the primates. Further, communication of abstractions such as "how," "why," or "when" is difficult to detect or measure. How can Klinowska be so sure that cetaceans are incapable of such communication?

The behavior of dolphins is particularly striking given the presumed simplicity of their brains. Their well-documented capacity for concrete communication goes far beyond that of some animals with more "complex" brains. As the birds and the bats show us, different structures can perform the same function.

Thomas Q. Garvey IV
Potomac, Maryland

To the Editor:

Ms. Klinowska's article "How Brainy are Cetaceans?" was most disappointing. She obviously has not kept up with current research. For example, she downplays the importance of the size of the neocortex in assessing intelligence (cognitive ability). Ms. Klinowska apparently has not read recent papers by H. J. Jerison of UCLA. He affirms not only that the cetaceans are extremely high in encephalization, but that encephalization is the most important measure of intelligence in other species: "If the idea of intelligence were unknown, it would have to be invented to explain encephalization." She cites evidence (outdated) that cetaceans do not have a complicated social life; despite the fact that the acknowledged world authority, Dr. Kenneth Norris said ". . .in dolphins we are surely dealing with complicated social systems whose outlines we are now just beginning to understand."

Ms. Klinowska asserts that dolphins cannot be as intelligent as humans because their brain cortex lacks some features that terrestrial mammals developed after the evolutionary divergence of the cetaceans from their terrestrial forebears. For 60 million years cetaceans have evolved in an environment radically different from that of the rest of mammalia. Their external morphology has diverged more extremely from early mammalian stock than any other mammal. Is there any reason their cerebral evolution would not have kept pace? Just because the cetacean brain is different—and it is very different—does not mean it is less evolved. To say cetaceans are not "brainy" simply because their brains do not show the same evolutionary developments as terrestrial mammals is equivalent to insisting that bats cannot fly because they never evolved feathers. One lesson which the study of evolution makes abundantly clear is that there are many possible pathways to the same objective.

Dexter Cate,
Senior Research Associate,
Institute for Pacific Marine Research
Kailua, Hawaii

To The Editor:

I would like to congratulate you on your Spring 1989 issue, "Whither the Whales?" The breadth of the issue plus the timeliness of the articles make it a valuable resource for those interested in marine mammal problems. I will be sure to include it on my recommended reading lists.

May you produce many more such issues of *Oceanus*! With warm regards,

Richard Block
Director of Public Programs
World Wildlife Fund
Washington, DC

26th Underwater Photo Competition

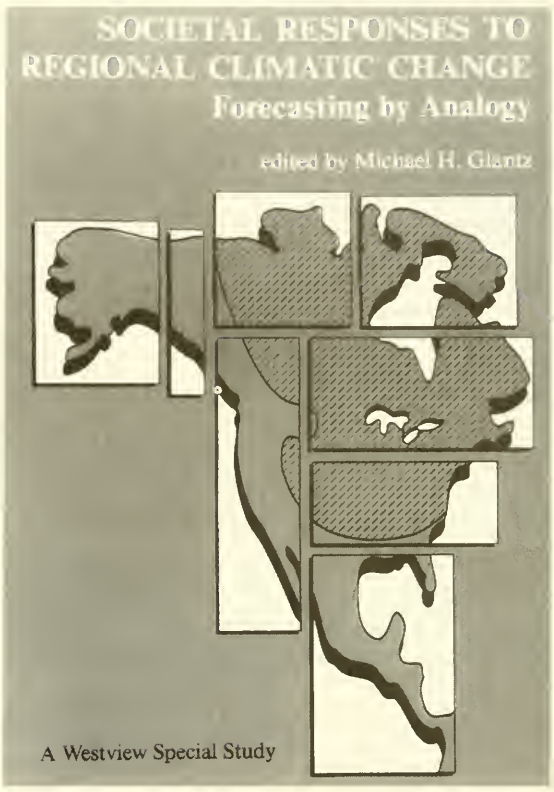
The Underwater Photographic Society of Los Angeles is sponsoring its twenty-seventh annual international Underwater Photographic Competition. Entrants from around the world are invited to compete with prints and slides in five categories. There is also a special shark competition co-sponsored by the Los Angeles County Museum of Natural History. The deadline for entries is October 14 and the judging will be held on October 21.

A plaque and $75 will be awarded to first place in each category, with a plaque and $25 for second place and a medal for third place. There will be $1,000 in prizes for the shark competition as well. "Best of Show" will be awarded a plaque plus round trip for two courtesy of Qantas Airways to Nadi, Fiji; five nights' accommodations for two at the Kontiki Resort, SavuSavu, Fiji, PLUS diving for two and two nights' accommodations in Nadi, Fiji. This package was compiled by Sea Safaris of Manhattan Beach, California.

For further information and complete competition rules, write to Lance Bennett, Underwater Photographic Society, P.O. Box 2401, Culver City, CA 90231-2401, USA.

book reviews

***Societal Responses to Regional Climatic Change: Forecasting By Analogy* edited by Michael H. Glantz. 1988. Westview Press, Boulder, CO. 428 pp. $40.00.**



As calls for draconian policy shifts grow more urgent in response to predictions of global warming, it becomes all the more important to be able to compare the costs of proposed policy measures to the estimated costs of climatic changes. Working with crude "scenarios" of possible changes, economists are able to generate even cruder estimates of their future economic impact. A crucial element in accurate impact estimation, however, is the nature and effect of human responses to the changes as they take place. It is silly to think that people will just sit there and absorb the worst, and it is probably reasonable to reckon that the measures they take over time—as changing conditions are observed and learning takes place—will reduce the impacts that otherwise would be felt. But how do we go about forecasting these responses? That is perhaps as perplexing a problem as forecasting the behavior of the physical climate system itself (and, in fact, the two problems are not unrelated).

This ambitious and useful volume presents one approach toward progress in forecasting human responses. Along the way, it also seeks to help with another problem. Many of the predicted climatic changes will probably be felt on a regional basis, but the computer-based climate simulation models from which predictions have been extrapolated cannot resolve to such a level. So, there is a limit not only to what can be said about how human responses will be organized regionally but also to what can be said about just what any region will be responding to. In short, there is very little to go on.

The approach taken by editor Glantz and his co-authors is to examine a collection of recent historical cases in which natural changes, like those expected with future climate change, have been experienced. These cases include changes in the level of the Great Lakes (by Stewart Cohen); the rising level of the Great Salt Lake (Peter Morrisette); wetlands erosion and relative sea-level rise in Louisiana (Mark Meo); changes in the flow and management of the Mississippi (William Koellner) and Colorado (Barbara Brown) rivers; critical withdrawals from the Occoquan Creek reservoir in Virginia (Daniel Sheer); citrus freezes in Florida (Kathleen Miller); and, depletion of the midwestern Ogallala Aquifer (Donald Wilhite).

As suggested by these examples, the experience considered is all-American. With such diversity in authorship, disciplinary backgrounds, and case examples, it is not surprising that the volume is eclectic in the extreme and of variable quality. Still, each of the case studies will be of interest to readers interested in how society responds to environmental change, and Glantz does a commendable job of teasing generalizations and unifying themes from the disparate material.

This job is especially difficult because of some intrinsic traps and pitfalls in the forecasting-by-analogy approach. These limitations are recognized and acknowledged by Glantz, and are spelled out by philosopher Dale Jamieson in a background essay. In another helpful essay, statistician Richard Katz outlines the fragile basis on which climate predictions are built. The biggest problem faced by the editor in imposing order on the results of the case studies, however, is simply that the exact questions being asked and the methods by which answers are derived vary so widely from example to example. The basis for inference and convincing generalization is very thin, but it turns out to be worth the try.

Glantz finds, "In all cases ad hoc responses were favored over longer-term planned responses. As a result, there has been a tendency to 'muddle through.'" True, "This has not necessarily been an inappropriate response," but he then begs a fundamental question by expounding with little evidence from the cases, "but it is probably more costly in the long run than putting a long-term strategy together in order to cope with climate-related environmental change." Another noteworthy generalization is, "The Colorado River study suggests...that when the winners and losers have been identified there will be little interest on the part of the winners to alter their status in order to compensate the losers." The importance of coalition building, if action is to be achieved on contentious responses, is also emphasized.

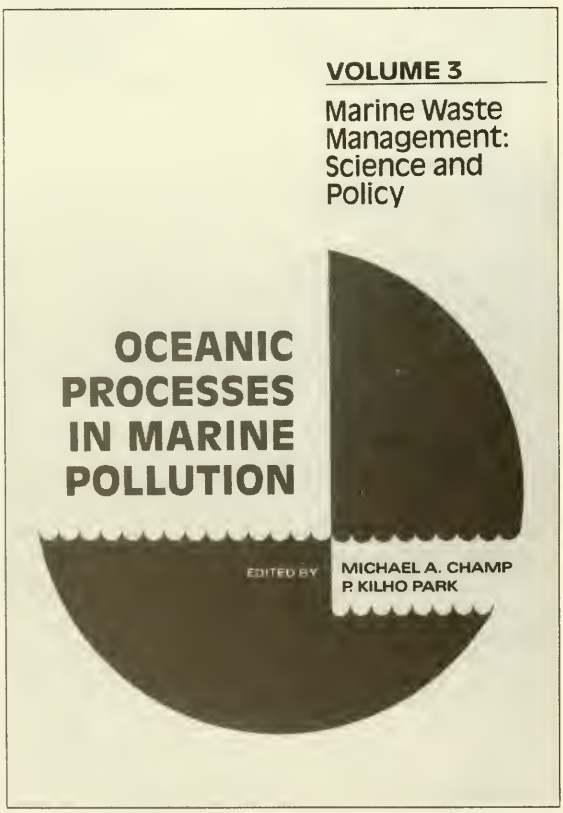
My own favorite finding does not even make Glantz's summary list. It emerges from Mark Meo's thoughtful examination of institutional responses to sea-level rise in Louisiana. For a variety of reasons, but most notably because of the navigational harnessing of the Mississippi River and the construction of access canal networks for oil and gas development in the delta's wetlands, coastal land loss to erosion and subsidence in the delta has accelerated to more than 50 square miles a year.

Because the process has been gradual, and because the scientific bases of the process were poorly understood, coherent public responses were slow to

emerge. This situation placed a premium on further scientific research. Once stakeholders such as property owners became convinced of their exposure and mobilized public action, however, a strange thing happened to the role of science. As Meo writes, "Recognition of the personal impacts attributable to cumulative wetland loss not only catalyzed greater public demand for collective action and the strengthening of state and local institutional capacity to mitigate damages, but also served to diminish the legitimate and pressing need for additional scientific research." In view of the huge uncertainties remaining about the global climate system, the unarguable importance of further scientific research on the questions of global warming, and the insistent push by some for immediate and major policy responses, this is one lesson from analogy that bears frequent repetition.

James M. Broadus
Director, Marine Policy Center
Woods Hole Oceanographic Institution

***Oceanic Processes in Marine Pollution, Volume 3, Marine Waste Management: Science and Policy* by Michael A. Champ and P. Kilho Park. 1989. Robert E. Krieger, Malabar, Florida. 341 pp. $64.50.**



Oceanic Processes in Marine Pollution is to be a series of six reference books under the general editorship of Iver Duedall, Dana Kester, and P. Kilho Park. Volume three is the result of the efforts of 59 authors, and consists of 26 chapters organized into four parts. The volume is dedicated to Peter W. Anderson, former Chief of U.S. EPA Region Two Water Permits and Compliance Branch, who died in 1984.

I enjoyed the book very much, and found it to be an excellent reference, however, I have three criticisms of the volume. First, the technical sections lack economic information. Most economic analyses are incorporated in the risk assessment chapters. The only general economic analysis is in Part IV, and was well written by a lawyer. My prejudice is that policy makers, the industries that rely upon the ocean as a disposal site, and students would have been better served by a more thorough consideration of the technical economic issues.

Second, the introduction does not provide the reader with an adequate history of the book. Was the volume a result of technical meetings or joint research programs? Were the papers commissioned for this volume specifically, or gleaned from professional meetings on other subjects?

Third, the volume is deficient in its discussion of source reduction. There are, by implication, ever-increasing amounts of waste to be assimilated by the ocean. Only a few authors indicated that waste-generating practices might be altered. Kenneth S. Kamlet (page 111) gives four major management and regulatory approaches, of which one, the "hierarchical approach," would encourage source reduction and resource recovery first, destruction and treatment second, and disposal or dispersal last. However, he then rejects this approach on page 119 by saying it is difficult to do cost/benefit analyses of it, and because beneficial technologies are often the most costly. In a volume that provides so little economic information, this assertion is difficult to assess.

Part I gives a summary of sewage sludge, industrial and municipal waste, dredged material, low-level radioactive waste, and coal waste disposal in the ocean. The authors point out the need for safeguards with all media and all methods, but, in general, support the ocean's assimilative capacity for waste disposal. R. Lawrence Swanson and Garry F. Mayer point out that some disposal choices carry with them a reflection of society's willingness to accept limited, predictable levels of environmental degradation as the price of waste disposal (page 36). However, Willard N. Bascom (page 25) notes that sewage sludge, if properly disposed, has beneficial effects in the ocean since the sludge is a food source for many organisms. Susan E. Harvey (page 97) points out that, thus far, artificial reefs made of coal wastes have not had detrimental effects on the environment.

Public policy regarding ocean disposal, as summarized in the five chapters of Part II, Ocean Disposal Legislative Development: National and International, seems to have arisen from shared concerns over public health and environmental protection. Not all of the environmental protection concern is altruistic; much of the international law came about to protect us from our neighbor's dumping, not our own. Thomas R. Kitsos, William W. Steele, Jr., and Susan Wade (page 101) point out that science is important, but that decisions about ocean disposal are social and political—not technical—and by inference, not rigorous. The authors in Part III believe that these social and political decisions can, indeed, be rigorous.

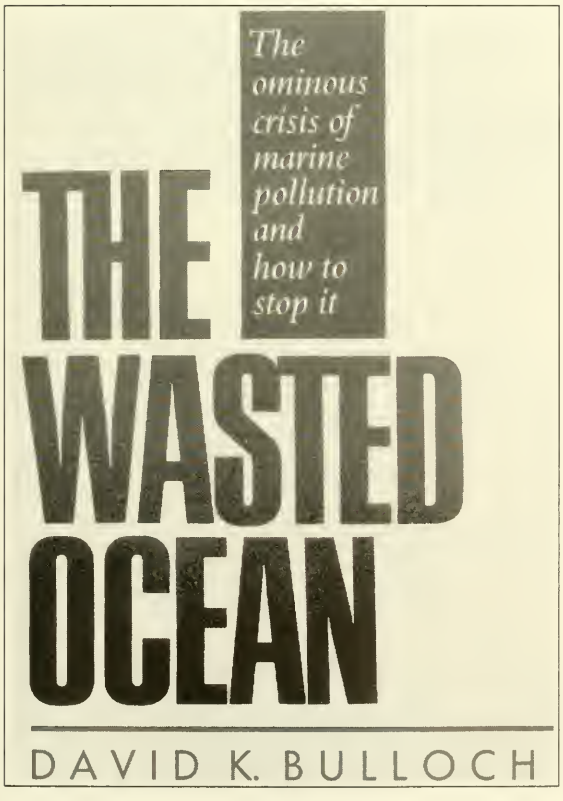
Part III, Ocean Disposal: Assessment Technology, is the largest section of the book, with 11

chapters and more variety than the other sections. It is divided into three parts: dumpsite selection criteria; hazard evaluation and risk analysis; and monitoring strategies. Some chapters are highly technical and offer specific methods for incorporating scientific information into the decision-making process. As computer proficiency becomes universal, these methods for information assessment may be used more commonly by policy makers. At present, these chapters are valuable for general education.

Part IV, Waste Disposal Strategies, appears to be a catch-all for chapters that did not fit in elsewhere; however, these four chapters are among my favorites. The volume provides a clear summary of *what* we dump in the ocean, methods for choosing *where* to dump various materials, and *how* to dump them. But it does not address directly the question of *why* until Part IV. William L. Lahey (page 288) points out that wastes are discharged to the air and water because those choices are free or inexpensive, not out of malevolence. This is an important point, and should have been stressed earlier in the volume.

The editors do a fine job of avoiding jargon; they provide a list of acronyms and initialisms (a new word to me) at the beginning; all of the articles are readable. Most of the articles would be useful for marine policy courses at either the undergraduate or graduate level. The editors creatively include a number of cartoons, which both enliven the reading and divide the major sections of the volume.

Susan Peterson
President, Ecological Engineering, Inc.
Falmouth, Massachusetts



***The Wasted Ocean* by David K. Bulloch. 1989. Lyons & Burford, New York, NY. 150 pp. + x. $16.95.**

Headlines bewailing coastal pollution have become commonplace since the summer of 1988 when east coast beaches were awash with medical waste, and the *Exxon Valdez* oil spill has kept the topic a focus of public attention. But has society become careless only in the recent past, or are we facing age-old problems brought to our attention by these strikingly visible examples?

David K. Bulloch provides a well-balanced and critical view of society's role in coastal pollution with a review covering a century of problems and our attempts to solve them. He examines not only the most obvious signs—hypodermic needles and oil spills—but also chronic sources of contaminants from sewage, industrial discharges, disposal of dredged materials, and problems associated with plastics and disposal of nuclear wastes.

Bulloch gives an excellent survey of regional problems, both past and present. In addition, he presents a history of environmental legislation and discusses problems related to the enforcement of such legislation. The volume concludes with an impassioned plea for public involvement and public action in reversing the trends of increasing coastal degradation.

I would enjoy debating several key issues on coastal pollution with Bulloch, for instance whether the ocean *should* play a role in waste disposal. Nonetheless, I congratulate him on providing an informed and balanced view of coastal pollution, and for bringing the public's responsibility in coastal environmental protection to the forefront. It is an enjoyable book with an extremely important message.

Judith McDowell Capuzzo
Associate Scientist, Biology
Woods Hole Oceanographic Institution

Books Received

Biology

Diverse Divers, Physiology and Behavior by G. L. Kooyman. 1989. Springer-Verlag, Secaucus, NJ 07094. 200 pp. + ix. $99.00.

Encounters with Whales & Dolphins by Wade Doak. 1989. Sheridan House, Dobbs Ferry, NY 10522. 250 pp. $29.95.

The Endangered Kingdom: The Struggle to Save America's Wildlife by Roger L. DiSilvestro. 1989. John Wiley & Sons, New York, NY 10158. 241 pp. + vii. $19.95.

High Latitude Limnology edited by W. F. Vincent and J. C. Ellis-Evans. 1989. Kluwer Academic Publishers, Norwell, MA 02061. 323 pp. + ix. $138.50.

Perspectives on Biogeochemistry by Egon T. Degens. 1989. Springer-Verlag, Secaucus, NJ 07094. 423 pp. + viii. $59.00.

Culture of Science

Bubbles, Voids, and Bumps in Time: The New Cosmology edited by James Cornell. 1989. Cambridge University Press, New Rochelle, NY 10801. 190 pp. + xiii. $22.95.

Ecology in the 20th Century: A History by Anna Bramwell. 1989. Yale University Press, New Haven, CT 06250. 292 pp. + xii. $16.95.

For the Love of Enzymes: The Odyssey of a Biochemist by Arthur Kornberg. 1989. Harvard University Press, Cambridge, MA 02138. 336 pp. + xi. $29.95.

Multiple Exposures: Chronicles of the Radiation Age by Catherine Caufield. 1989. Harper & Row Publishers, NY. 304 pp. + vii. $19.95.

Earth Science

Nanofossils and Their Applications edited by Jason A. Crux and Shirley E. van Heck. 1989. John Wiley & Sons, New York, NY 10158. 356 pp. + xi. $125.00.

Origins of Igneous Rocks by Paul C. Hess. Harvard University Press, Cambridge, MA 02138. 336 pp. $65.00.

Environment

Acid Rain and Friendly Neighbors: The Policy Dispute Between Canada and the United States edited by Jurgen Schmandt, Judith Clarkson, and Hilliard Roderick. 1989. Duke University Press, Durham, NC 27708. 344 pp. + xv. $45.00.

A Citizens' Guide to Protecting Wetlands by The National Wildlife Foundation. 1989. Washington, DC 20036. 64 pp. $10.25.

The Demise of Nuclear Energy? Lessons for Democratic Control of Technology by Joseph G. Morone and Edward J. Woodhouse. 1989. Yale University Press, New Haven, CT 06250. 172 pp. + xii. $6.95.

Environmentalism and the Future of Progressive Politics by Robert C. Paehlke. 1989. Yale University Press, New Haven, CT 06250. 325 pp. $25.00.

Ozone Crisis by Sharon L. Roan. 1989. John Wiley & Sons, New York, NY 10158. 270 pp. + xviii. $18.95.

Ronald Reagan and the Public Lands: America's Conservation Debate by C. Brant Short. Texas A&M University Press, College Station, TX 77843. 178 pp. + xi. $13.95.

Field Guides

The Amphibians and Reptiles of Louisiana by Harold A. Dundee and Douglas A. Rossman. 1989. Louisiana State University Press, Baton Rouge, LA 70893. 300 pp. + xi. $29.95.

Discover the Great Barrier Reef Marine Park compiled by Lesley Murdoch. 1989. Bay Books, New South Wales, Australia. 96 pp. $14.00.

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Whither the Whales?

Vol. 32:1, Spring, 1989—Perhaps the most complete and in-depth summary of cetacean research generally available. Find out which whales are really endangered; how intelligent they are; the latest research methods, including satellite tracking and photo-ID studies; the importance of whaling to the Eskimos, Japanese and Icelanders; and what's known about dolphin society.

DSV Alvin: 25 Years of Discovery

Vol. 31:4, Winter 1988/89—A 25th anniversary salute to "the stubby little sub that could," reviewing the design and history of oceanography's first research submersible. Covers its exploits from the hair-raising search for a lost hydrogen bomb in 1966, to its role in deep-sea microbiology, and the recent exciting discovery of a low-level glow at deep-sea hot vents.

Sea Grant Issue

Vol. 31:3, Fall 1988—Since 1966 the National Sea Grant Program has been supporting coastal and marine education, research, and advisory services. Articles span the spectrum of Sea Grant activities, which include rehabilitating the world's largest freshwater estuary, organizing citizen volunteers for environmental monitoring, and the new field of shellfish biotechnology.

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  Vol. 31:2, Summer 1988—It's role in climate, international affairs,and more.
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- **Beaches, Bioluminescence, and Pollution,**
  Vol. 28:3, Fall 1985—Science in Cuba, and Jacques Cousteau's turbosail vessel.
- **The Oceans and National Security,**
  Vol. 28:2, Summer 1985—The oceans from the viewpoint of the modern navy, strategy, technology, weapons systems, and science.
- **The Exclusive Economic Zone,**
  Vol. 27:4, Winter 1984/85—Options for the U.S. EEZ.
- **Deep-Sea Hot Springs and Cold Seeps,**
  Vol. 27:3, Fall 1984—A full report on vent science.
- **Industry and the Oceans,**
  Vol. 27:1, Spring 1984
- **Oceanography in China,**
  Vol. 26:4, Winter 1983/84—U.S.-Chinese collaboration, tectonics, aquaculture, and more.
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- **General Issue,**
  Vol. 25:2, Summer 1982—Coastal resource management, acoustic tomography, aquaculture, radioactive waste.
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  Vol. 24:2, Summer 1981—Aquatic plants, seabirds, and offshore oil and gas.

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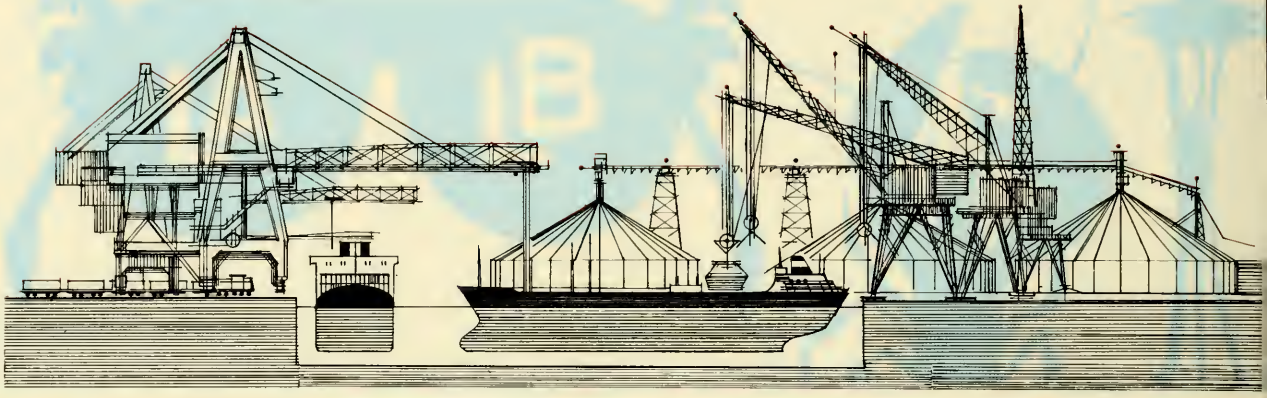

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